THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XV.—No. 353.

THE BRITISH ASSOCIATION MEETING IN CANADA.

THE proceedings of the Association opened on Wednesday afternoon at the M'Gill College, Montreal, which has been prepared for the meetings of the sections, having the necessary offices, including postal and telegraph facilities, writing rooms, &c. Covered ways are constructed between the buildings, and a large tent is erected on the grounds for a dining hall. Extensive arrangements have been made for the excursions of the members to Quebec, Ottawa, and other places of interest in the Dominion and the United States, with garden parties, *soirées*, and receptions in the intervals of the meetings. The citizens of Quebec were arranging to entertain 600 members to-day (Saturday). The people of Montreal are manifesting great interest in the meeting; a fund of $40,000 has been raised for the expenses, and it is said there would have been no difficulty in getting much more were it necessary.

About 800 British members had arrived up to the 25th inst., including nearly 400 by the steamers *Parisian*, *Polynesian*, and *Oregon*. These 400 gentlemen reached Montreal on Monday afternoon by railway from Quebec, and lodgings were assigned them in different parts of the town by Mr. Charles Garth, chairman of the local committee. The Montreal citizens provide private hospitality for over 300, the remainder going to hotels.

At the commencement of the proceedings on Wednesday afternoon an address was presented by the Mayor and Corporation. The opening meeting of the Association was held in the Queen's Hall in the evening, when Lord Rayleigh, M.A., D.C.L., F.R.S., F.R.A.S., F.R.G.S., Professor of Experimental Physics in the University of Cambridge, the President, was introduced by Sir William Thomson, and addressed a large and profoundly interested gathering as follows :—

IT is no ordinary meeting of the British Association which I have now the honour of addressing. For more than fifty years the Association has held its autumn gathering in various towns of the United Kingdom, and within those limits there is, I suppose, no place of importance which we have not visited. And now, not satisfied with past successes, we are seeking new worlds to conquer. When it was first proposed to visit Canada, there were some who viewed the project with hesitation. For my own part, I never quite understood the grounds of their apprehension. Perhaps they feared the thin edge of the wedge. When once the principle was admitted, there was no knowing to what it might lead. So rapid is the development of the British Empire, that the time might come when a visit to such out-of-the-way places as London or Manchester could no longer be claimed as a right, but only asked for as a concession to the susceptibilities of the English. But seriously, whatever objections may have at first been felt soon were outweighed by the consideration of the magnificent opportunities which your hospitality affords of extending the sphere of our influence and of becoming acquainted with a part of the Queen's dominion which, associated with splendid memories of the past, is advancing daily by leaps and bounds to a position of importance such as not long ago was scarcely dreamed of. For myself, I am not a stranger to your shores. I remember well the impression made upon me, seventeen years ago, by the wild rapids of the St. Lawrence, and the gloomy grandeur of the Saguenay. If anything impressed me more, it was the kindness with which I was received by yourselves, and which I doubt not will be again extended not merely to myself but to all the English members of the Association. I am confident that those who have made up their minds to cross the ocean will not repent their decision, and that, apart altogether from scientific interests, great advantage may be expected from this visit. We Englishmen ought to know more than we do of matters relating to the Colonies, and anything which tends to bring the various parts of the Empire into closer contact can hardly be overvalued. It is pleasant to think that this Association is the means of furthering an object which should be dear to the hearts of all of us; and I venture to say that a large proportion of the visitors to this country will be astonished by what they see, and will carry home an impression which time will not readily efface.

To be connected with this meeting is, to me, a great honour, but also a great responsibility. In one respect, especially, I feel that the Association might have done well to choose another president. My own tastes have led me to study mathematics and physics rather than geology and biology, to which naturally more attention turns in a new country, presenting as it does a fresh field for investigation. A chronicle of achievements in these departments by workers from among yourselves would have been suitable to the occasion, but could not come from me. If you would have preferred a different subject for this address, I hope, at least, that you will not hold me entirely responsible.

At annual gatherings like ours the pleasure with which friends meet friends again is sadly marred by the absence of those who can never more take their part in our proceedings. Last year my predecessor in this office had to lament the untimely loss of Spottiswoode and Henry Smith, dear friends of many of us, and prominent members of our Association. And now, again, a well-known form is missing. For many years Sir W. Siemens has been a regular attendant at our meetings, and to few indeed have they been more indebted for success. Whatever the occasion, in his Presidential Address of two years ago, or in communications to the Physical and Mechanical Sections, he had always new and interesting ideas, put forward in language which a child could understand, so great a master was he of the art of lucid statement in his adopted tongue. Practice with Science was his motto. Deeply engaged in industry, and conversant, all his life, with engineering operations, his opinion was never that of a mere theorist. On the other hand, he abhorred rule of thumb, striving always to master the scientific principles which underlie rational design and invention.

It is not necessary that I should review in detail the work of Siemens. The part which he took, during recent years, in the development of the dynamo machine must be known to many of you. We owe to him the practical adoption of the method, first suggested by Wheatstone, of throwing into a shunt the coils of the field-magnets, by which a greatly improved steadiness of action is obtained. The same characteristics are observable throughout—a definite object in view and a well-directed perseverance in overcoming the difficulties by which the path is usually obstructed.

These are, indeed, the conditions of successful invention. The world knows little of such things, and regards the new machine or the new method as the immediate outcome of a happy idea. Probably, if the truth were known, we should see that, in nine cases out of ten, success depends as much upon good judgment and perseverance as upon fertility of imagination. The labours of our great inventors are not unappreciated, but I doubt whether we adequately realise the enormous obligations under which we lie. It is no exaggeration to say that the life of such a man as Siemens is spent in the public service; the advantages which he reaps for himself being as nothing in comparison with those which he confers upon the community at large.

As an example of this it will be sufficient to mention one of the most valuable achievements of his active life—his introduction, in conjunction with his brother, of the regenerative gas furnace, by which an immense economy of fuel (estimated at millions of tons annually) has been effected in the manufacture of steel and glass. The nature of this economy is easily explained. Whatever may be the work to be done by the burning of fuel, a certain *temperature* is necessary. For example, no amount of heat in the form of boiling water would be of any avail for the fusion of steel. When the products of combustion are cooled down to the point in question, the heat which they still contain is useless as regards the purpose in view. The importance of this consideration depends entirely upon the working temperature. If the object be the evaporation of water or the warming of a house, almost all the heat may be extracted from the fuel without special arrangements. But it is otherwise when the temperature required is not much below that of combustion itself, for then the escaping gases carry away with them the larger part of the whole heat developed. It was to meet this difficulty that the regenerative furnace was devised. The products of combustion, before dismissal into the chimney, are caused to pass through piles of loosely stacked fire-brick, to which they give up their heat. After a time the fire-brick, upon which the gases first impinge, becomes nearly as hot as the furnace itself. By suitable valves the burnt gases are then

diverted through another stack of brickwork, which they heat up in like manner, while the heat stored up in the first stack is utilised to warm the unburnt gas and air on their way to the furnace. In this way almost all the heat developed at a high temperature during the combustion is made available for the work in hand.

As it is now several years since your presidential chair has been occupied by a professed physicist, it may naturally be expected that I should attempt some record of recent progress in that branch of science, if indeed such a term be applicable. For it is one of the difficulties of the task that subjects as distinct as mechanics, electricity, heat, optics and acoustics, to say nothing of astronomy and meteorology, are included under physics. Any one of these may well occupy the life-long attention of a man of science, and to be thoroughly conversant with all of them is more than can be expected of any one individual, and is probably incompatible with the devotion of much time and energy to the actual advancement of knowledge. Not that I would complain of the association sanctioned by common parlance. A sound knowledge of at least the principles of general physics is necessary to the cultivation of any department. The predominance of the sense of sight as the medium of communication with the outer world, brings with it dependence upon the science of optics; and there is hardly a branch of science in which the effects of *temperature* have not (often without much success) to be reckoned with. Besides, the neglected borderland between two branches of knowledge is often that which best repays cultivation, or, to use a metaphor of Maxwell's, the greatest benefits may be derived from a cross fertilisation of the sciences. The wealth of material is an evil only from the point of view of one of whom too much may be expected. Another difficulty incident to the task, which must be faced but cannot be overcome, is that of estimating rightly the value, and even the correctness, of recent work. It is not always that which seems at first the most important that proves in the end to be so. The history of science teems with examples of discoveries which attracted little notice at the time, but afterwards have taken root downwards and borne much fruit upwards.

One of the most striking advances of recent years is in the production and application of electricity upon a large scale—a subject to which I have already had occasion to allude in connection with the work of Sir W. Siemens. The dynamo machine is indeed founded upon discoveries of Faraday now more than half a century old; but it has required the protracted labours of many inventors to bring it to its present high degrèe of efficiency. Looking back at the matter, it seems strange that progress should have been so slow. I do not refer to details of design, the elaboration of which must always, I suppose, require the experience of actual work to indicate what parts are structurally weaker than they should be, or are exposed to undue wear and tear. But with regard to the main features of the problem, it would almost seem as if the difficulty lay in want of faith. Long ago it was recognised that electricity derived from chemical action is (on a large scale) too expensive a source of mechanical power, notwithstanding the fact that (as proved by Joule in 1846) the conversion of electrical into mechanical work can be effected with great economy. From this it is an evident consequence that electricity may advantageously be obtained from mechanical power; and one cannot help thinking that if the fact had been borne steadily in mind, the development of the dynamo might have been much more rapid. But discoveries and inventions are apt to appear obvious when regarded from the stand-point of accomplished fact; and I draw attention to the matter only to point the moral that we do well to push the attack persistently when we can be sure beforehand that the obstacles to be overcome are only difficulties of contrivance, and that we are not vainly fighting unawares against a law of Nature.

The present development of electricity on a large scale depends, however, almost as much upon the incandescent lamp as upon the dynamo. The success of these lamps demands a very perfect vacuum—not more than about one millionth of the normal quantity of air should remain—and it is interesting to recall that, twenty years ago, such vacua were rare even in the laboratory of the physicist. It is pretty safe to say that these wonderful results would never have been accomplished had practical applications alone been in view. The way was prepared by an army of scientific men whose main object was the advancement of knowledge, and who could scarcely have imagined that the processes which they elaborated would soon be in use on a commercial scale and entrusted to the hands of ordinary workmen.

When I speak in hopeful language of practical electricity, I do not forget the disappointment within the last year or two of many over-sanguine expectations. The enthusiasm of the inventor and promoter are necessary to progress, and it seems to be almost a law of nature that it should overpass the bounds marked out by reason and experience. What is most to be regretted is the advantage taken by speculators of the often uninstructed interest felt by the public in novel schemes by which its imagination is fired. But looking forward to the future of electric lighting, we have good ground for encouragement. Already the lighting of large passenger ships is an assured success, and one which will be highly appreciated by those travellers who have experienced the tedium of long winter evenings unrelieved by adequate illumination. Here, no doubt, the conditions are in many respects especially favourable. As regards space, life on board ship is highly concentrated; while unity of management and the presence on the spot of skilled engineers obviate some of the difficulties that are met with under other circumstances. At present we have no experience of a house-to-house system of illumination on a great scale and in competition with cheap gas; but preparations are already far advanced for trial on an adequate scale in London. In large institutions, such as theatres and factories, we all know that electricity is in successful and daily extending operation.

When the necessary power can be obtained from the fall of water, instead of from the combustion of coal, the conditions of the problem are far more favourable. Possibly the severity of your winters may prove an obstacle, but it is impossible to regard your splendid river without the thought arising that the day may come when the vast powers now running to waste shall be bent into your service. Such a project demands of course the most careful consideration, but it is one worthy of an intelligent and enterprising community.

The requirements of practice react in the most healthy manner upon scientific electricity. Just as in former days the science received a stimulus from the application to telegraphy, under which everything relating to measurement on a small scale acquired an importance and development for which we might otherwise have had long to wait, so now the requirements of electric lighting are giving rise to a new development of the art of measurement upon a large scale, which cannot fail to prove of scientific as well as practical importance. Mere change of scale may not at first appear a very important matter, but it is surprising how much modification it entails in the instruments, and in the processes of measurement. For instance, the resistance coils on which the electrician relies in dealing with currents whose maximum is a fraction of an ampère, fail altogether when it becomes a question of hundreds, not to say thousands, of ampères.

The powerful currents which are now at command, constitute almost a new weapon in the hands of the physicist. Effects, which in old days were rare and difficult of observation, may now be produced at will on the most conspicuous scale. Consider for a moment Faraday's great discovery of the "Magnetisation of Light," which Tyndall likens to the Weisshorn among mountains, as high, beautiful, and alone. This judgment (in which I fully concur) relates to the scientific aspect of the discovery, for to the eye of sense nothing could have been more insignificant. It is even possible that it might have eluded altogether the penetration of Faraday, had he not been provided with a special quality of very heavy glass. At the present day these effects may be produced upon a scale that would have delighted their discoverer, a rotation of the plane of polarisation through 180° being perfectly feasible. With the aid of modern appliances, Kundt and Röntgen in Germany, and H. Becquerel in France, have detected the rotation in gases and vapours, where, on account of its extreme smallness, it had previously escaped notice.

Again, the question of the magnetic saturation of iron has now an importance entirely beyond what it possessed at the time of Joule's early observations. Then it required special arrangements purposely contrived to bring it into prominence. Now in every dynamo machine, the iron of the field-magnets approaches a state of saturation, and the very elements of an explanation of the action require us to take the fact into account. It is indeed probable that a better knowledge of this subject might lead to improvements in the design of these machines.

Notwithstanding the important work of Rowland and Stoletow, the whole theory of the behaviour of soft iron under varying magnetic conditions is still somewhat obscure. Much may be hoped from the induction balance of Hughes, by which the marvellous powers of the telephone are applied to the discrimination of the properties of metals, as regards magnetism and electric conductivity.

The introduction of powerful alternate-current in machines by Siemens, Gordon, Ferranti, and others, is likely also to have a salutary effect in educating those so-called practical electricians whose ideas do not easily rise above ohms and volts. It has long been known that when the changes are sufficiently rapid the phenomena are governed much more by induction, or electric inertia, than by mere resistance. On this principle much may be explained that would otherwise seem paradoxical. To take a comparatively simple case—conceive an electro-magnet wound with two contiguous wires, upon which acts a given rapidly periodic electromotive force. If one wire only be used a certain amount of heat is developed in the circuit. Suppose now that the second wire is brought into operation in parallel—a proceeding equivalent to doubling the section of the original wire. An electrician accustomed only to constant currents would be sure to think that the heating effect would be doubled by the change, as much heat being developed in each wire separately as was at first in the single wire. But such a conclusion would be entirely erroneous. The total current, being governed practically by the self-induction of the circuit, would not be augmented by the accession of the second wire, and the total heating effect, so far from being doubled, would, in virtue of the superior conductivity, be halved.

During the last few years much interest has been felt in the reduction to an absolute standard of measurements of electromotive force, current, resistance, &c., and to this end many laborious investigations have been undertaken. The subject is one that has engaged a good deal of my own attention, and I should naturally have felt inclined to dilate upon it, but that I feel it to be too abstruse and special to be dealt with in detail upon an occasion like the present. As regards resistance, I will merely remind you that the recent determinations have shown a so greatly improved agreement that the Conference of Electricians

assembled at Paris, in May, have felt themselves justified in defining the ohm for practical use as the resistance of a column of mercury at 0° C., of 1 square millimetre in section, and 106 centimetres in length—a definition differing by a little more than 1 per cent. from that arrived at 20 years ago by a committee of this Association.

A standard of resistance once determined upon can be embodied in a "resistance coil," and copied without much trouble, and with great accuracy. But in order to complete the electrical system a second standard of some kind is necessary, and this is not so easily embodied in a permanent form. It might conveniently consist of a standard galvanic cell, capable of being prepared in a definite manner, whose electromotive force is once for all determined. Unfortunately most of the batteries in ordinary use are, for one reason or another, unsuitable for this purpose, but the cell introduced by Mr. Latimer Clark, in which the metals are zinc in contact with saturated zinc sulphate and pure mercury in contact with mercurous sulphate, appears to give satisfactory results. According to my measurements the electromotive force of this cell is 1·435 theoretical volts.

We may also conveniently express the second absolute electrical measurement necessary to the completion of the system by taking advantage of Faraday's law, that the quantity of metal decomposed in an electrolytic cell is proportional to the whole quantity of electricity that passes. The best metal for the purpose is silver, deposited from a solution of the nitrate or of the chlorate. The results recently obtained by Prof. Kohlrausch and by myself are in very good agreement, and the conclusion that one ampère flowing for one hour decomposes 4·025 grains of silver, can hardly be in error by more than a thousandth part. This number being known the silver voltameter gives a ready and very accurate method of measuring currents of intensity varying from $\frac{1}{10}$ ampère to 4 or 5 ampères.

The beautiful and mysterious phenomena attending the discharge of electricity in nearly vacuous spaces have been investigated, and in some degree explained by De la Rue, Crookes, Schuster, Moulton, and the lamented Spottiswoode, as well as by various able foreign experimenters. In a recent research Crookes has sought the origin of a bright citron-coloured band in the phosphorescent spectrum of certain earths, and after encountering difficulties and anomalies of a most bewildering kind, has succeeded in proving that it is due to yttrium, an element much more widely distributed than had been supposed. A conclusion like this is stated in a few words, but those only who have undergone similar experience are likely to appreciate the skill and perseverance of which it is the final reward.

A remarkable observation by Hall, of Baltimore, from which it appeared that the flow of electricity in a conducting sheet was disturbed by magnetic force has been the subject of much discussion. Mr. Shelford Bidwell has brought forward experiments tending to prove that the effect is of a secondary character, due in the first instance to the mechanical force operating upon the conductor of an electric current when situated in a powerful magnetic field. Mr. Bidwell's view agrees in the main with Mr. Hall's division of the metals into two groups according to the direction of the effect.

Without doubt the most important achievement of the older generation of scientific men has been the establishment and application of the great laws of thermo-dynamics, or, as it is often called, the mechanical theory of heat. The first law, which asserts that heat and mechanical work can be transformed one into the other at a certain fixed rate, is now well understood by every student of physics, and the number expressing the mechanical equivalent of heat resulting from the experiments of Joule has been confirmed by the researches of others, and especially of Rowland. But the second law, which practically is even more important than the first, is only now beginning to receive the full appreciation due to it. One reason of this may be found in a not unnatural confusion of ideas. Words do not always lend themselves readily to the demands that are made upon them by a growing science, and I think that the almost unavoidable use of the word equivalent in the statement of the first law is partly responsible for the little attention that is given to the second. For the second law so far contradicts the usual statement of the first, as to assert that equivalents of heat and work are not of equal value. While work can always be converted into heat, heat can only be converted into work under certain limitations. For every practical purpose the work is worth the most, and when we speak of equivalents, we use the word in the same sort of special sense as that in which chemists speak of equivalents of gold and iron. The second law teaches us that the real value of heat, as a source of mechanical power, depends upon the temperature of the body in which it resides; the hotter the body in relation to its surroundings, the more available the heat.

In order to see the relations which obtain between the first and the second law of thermo-dynamics, it is only necessary for us to glance at the theory of the steam-engine. Not many years ago calculations were plentiful, demonstrating the inefficiency of the steam-engine on the basis of a comparison of the work actually got out of the engine with the mechanical equivalent of the heat supplied to the boiler. Such calculations took into account only the first law of thermo-dynamics, which deals with the equivalents of heat and work, and have very little bearing upon the practical question of efficiency, which requires us to have regard also to the second law. According to that law the fraction of the total energy which can be converted into work depends upon the relative temperatures of the boiler and condenser; and it is, therefore, manifest that, as the temperature of the boiler cannot be raised indefinitely, it is impossible to utilise all the energy which, according to the first law of thermo-dynamics, is resident in the coal.

On a sounder view of the matter, the efficiency of the steam-engine is found to be so high, that there is no great margin remaining for improvement. The higher inital temperature possible in the gas engine opens out much wider possibilities, and many good judges look forward to a time when the steam-engine will have to give way to its younger rival.

To return to the theoretical question, we may say with Sir W. Thomson, that though energy cannot be destroyed, it ever tends to be dissipated, or to pass from more available to less available forms. No one who has grasped this principle can fail to recognise its immense importance in the system of the Universe. Every change—chemical, thermal, or mechanical—which takes place, or can take place, in Nature does so, at the cost of a certain amount of available energy. If, therefore, we wish to enquire whether or not a proposed transformation can take place, the question to be considered is whether its occurrence would involve dissipation of energy. If not, the transformation is (under the circumstances of the case) absolutely excluded. Some years ago, in a lecture at the Royal Institution, I endeavoured to draw the attention of chemists to the importance of the principle of dissipation in relation to their science, pointing out the error of the usual assumption that a general criterion is to be found in respect of the development of heat. For example, the solution of a salt in water is, if I may be allowed the phrase, a downhill transformation. It involves dissipation of energy, and can therefore go forward; but in many cases it is associated with the absorption rather than with the development of heat. I am glad to take advantage of the present opportunity in order to repeat my recommendation, with an emphasis justified by actual achievement. The foundations laid by Thomson now bear an edifice of no mean proportions, thanks to the labours of several physicists, among whom must be specially mentioned Willard Gibbs and Helmholtz. The former has elaborated a theory of the equilibrium of heterogeneous substances, wide in its principles, and we cannot doubt far-reaching in its consequences. In a series of masterly papers Helmholtz has developed the conception of *free energy* with very important applications to the theory of the galvanic cell. He points out that the mere tendency to solution bears in some cases no small proportion to the affinities more usually reckoned chemical, and contributes largely to the total electromotive force. Also in our own country Dr. Alder Wright has published some valuable experiments relating to the subject.

From the further study of electrolysis we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. I am not qualified—I wish I were—to speak to you on recent progress in general chemistry. Perhaps my feelings towards a first love may blind me, but I cannot help thinking that the next great advance, of which we have already some foreshadowing, will come on this side. And if I might without presumption venture a word of recommendation, it would be in favour of a more minute study of the simpler chemical phenomena.

Under the head of scientific mechanics it is principally in relatian to fluid motion that advances may be looked for. In speaking upon this subject I must limit myself almost entirely to experimental work. Theoretical hydro-dynamics, however important and interesting to the mathematician, are eminently unsuited to oral exposition. All I can do to attenuate an injustice, to which theorists are pretty well accustomed, is to refer you to the admirable reports of Mr. Hicks, published under the auspices of this Association.

The important and highly practical work of the late Mr. Froude in relation to the propulsion of ships is doubtless known to most of you. Recognising the fallacy of views then widely held as to the nature of the resistance to be overcome, he showed to demonstration that, in the case of fair-shaped bodies, we have to deal almost entirely with resistance dependent upon skin friction, and at high speeds upon the generation of surface waves by which energy is carried off. At speeds which are moderate in relation to the size of the ship, the resistance is practically dependent upon skin friction only. Although Prof. Stokes and other mathematicians had previously published calculations pointing to the same conclusion, there can be no doubt that the view generally entertained was very different. At the first meeting of the Association which I ever attended, as an intelligent listener, at Bath, in 1864, I well remember the surprise which greeted a statement by Rankine that he regarded skin friction as the only legitimate resistance to the progress of a well-designed ship. Mr. Froude's experiments have set the question at rest in a manner satisfactory to those who had little confidence in theoretical prevision.

In speaking of an explanation as satisfactory in which skin friction is accepted as the cause of resistance, I must guard myself against being supposed to mean that the nature of skin friction is itself well understood. Although its magnitude varies with the smoothness of the surface, we have no reason to think that it would disappear at any degree of smoothness consistent with an ultimate molecular structure. That it is connected with fluid viscosity is evident enough, but the *modus operandi* is still obscure.

Some important work bearing upon the subject has recently been published by Prof. O. Reynolds, who has investigated the flow of water in tubes as dependent upon the velocity of motion and upon the size of the bore. The laws of motion in capillary tubes,

discovered experimentally by Poiseuille, are in complete harmony with theory. The resistance varies as the velocity, and depends in a direct manner upon the constant of viscosity. But when we come to the larger pipes and higher velocities with which engineers usually have to deal, the theory which presupposes a regularly stratified motion evidently ceases to be applicable, and the problem becomes essentially identical with that of skin friction in relation to ship propulsion. Prof. Reynolds has traced with much success the passage from the one state of things to the other, and has proved the applicability under these complicated conditions of the general laws of dynamical similarity as adapted to viscous fluids by Prof. Stokes. In spite of the difficulties which beset both the theoretical and experimental treatment, we may hope to attain before long to a better understanding of a subject which is certainly second to none in scientific as well as practical interest.

As also closely connected with the mechanics of viscous fluids, I must not forget to mention an important series of experiments upon the friction of oiled surfaces, recently executed by Mr. Tower for the Institution of Mechanical Engineers. The results go far towards upsetting some ideas hitherto widely admitted. When the lubrication is adequate, the friction is found to be nearly independent of the load, and much smaller than is usually supposed, giving a coefficient as low as $\frac{1}{1000}$. When the layer of oil is well formed, the pressure between the solid surfaces is really borne by the fluid, and the work lost is spent in shearing, that is, in causing one stratum of the oil to glide over another.

In order to maintain its position, the fluid must possess a certain degree of viscosity, proportionate to the pressure; and even when this condition is satisfied, it would appear to be necessary that the layer should be thicker on the ingoing than on the outgoing side. We may, I believe, expect from Prof. Stokes a further elucidation of the processes involved. In the meantime, it is obvious that the results already obtained are of the utmost value, and fully justify the action of the Institution in devoting a part of its resources to experimental work. We may hope, indeed, that the example thus wisely set may be followed by other public bodies associated with various departments of industry.

I can do little more than refer to the interesting observations of Prof. Darwin, Mr. Hunt, and M. Forel on Ripplemark. The processes concerned would seem to be of a rather intricate character, and largely dependent upon fluid viscosity. It may be noted, indeed, that most of the still obscure phenomena of hydrodynamics require for their elucidation a better comprehension of the laws of viscous motion. The subject is one which offers peculiar difficulties. In some problems in which I have lately been interested, a circulating motion presents itself of the kind which the mathematician excludes from the first when he is treating of fluids destitute altogther of viscosity. The intensity of this motion proves, however, to be independent of the coefficient of viscosity, so that it cannot be correctly dismissed from consideration as a consequence of a supposition that the viscosity is infinitely small. The apparent breach of continuity can be explained, but it shows how much care is needful in dealing with the subject, and how easy it is to fall into error.

The nature of gaseous viscosity, as due to the diffusion of momentum, has been made clear by the theoretical and experimental researches of Maxwell. A flat disc moving in its own plane between two parallel solid surfaces is impeded by the necessity of shearing the intervening layers of gas, and the magnitude of the hindrance is proportional to the velocity of the motion and to the viscosity of the gas, so that under similar circumstances this effect may be taken as a measure, or rather definition, of the viscosity. From the dynamical theory of gases, to the development of which he contributed so much, Maxwell drew the startling conclusion that the viscosity of a gas should be independent of its density—that within wide limits the resistance to the moving disc should be scarcely diminished by pumping out the gas, so as to form a partial vacuum. Experiment fully confirmed this theoretical anticipation—one of the most remarkable to be found in the whole history of science—and proved that the swinging disc was retarded by the gas, as much when the barometer stood at half an inch as when it stood at 30 inches. It was obvious, of course, that the law must have a limit, that at a certain point of exhaustion the gas must begin to lose its power; and I remember discussing with Maxwell, soon after the publication of his experiments, the whereabouts of the point at which the gas would cease to produce its ordinary effect. His apparatus, however, was quite unsuited for high degrees of exhaustion, and the failure of the law was first observed by Kundt and Warburg, at pressures below 1 mm. of mercury. Subsequently the matter has been thoroughly examined by Crookes, who extended his observations to the highest degrees of exhaustion as measured by MacLeod's gauge. Perhaps the most remarkable results relate to hydrogen. From the atmospheric pressure of 760 mm. down to about $\frac{1}{4}$ mm. of mercury the viscosity is sensibly constant. From this point to the highest vacua, in which less than one millionth of the original gas remains, the coefficient of viscosity drops down gradually to a small fraction of its original value. In these vacua Mr. Crookes regards the gas as having assumed a different, ultra-gaseous, condition; but we must remember that the phenomena have relation to the other circumstances of the case, especially the dimensions of the vessel, as well as to the condition of the gas.

Such an achievement as the prediction of Maxwell's law of viscosity has, of course, drawn increased attention to the dynamical theory of gases. The success which has attended the theory in the hands of Clausius, Maxwell, Boltzmann and other mathematicians, not only in relation to viscosity, but over a large part of the entire field of our knowledge of gases, proves that some of its fundamental postulates are in harmony with the reality of Nature. At the same time, it presents serious difficulties; and we cannot but feel that while the electrical and optical properties of gases remain out of relation to the theory, no final judgment is possible. The growth of experimental knowledge may be trusted to clear up many doubtful points, and a younger generation of theorists will bring to bear improved mathematical weapons. In the meantime we may fairly congratulate ourselves on the possession of a guide which has already conducted us to a position which could hardly otherwise have been attained.

In optics attention has naturally centred upon the spectrum. The mystery attaching to the invisible rays lying beyond the red has been fathomed to an extent that, a few years ago, would have seemed almost impossible. By the use of special photographic methods Abney has mapped out the peculiarities of this region with such success that our knowledge of it begins to be comparable with that of the parts visible to the eye. Equally important work has been done by Langley, using a refined invention of his own based upon the principle of Siemens's pyrometer. This instrument measures the actual energy of the radiation, and thus expresses the effects of various parts of the spectrum upon a common scale, independent of the properties of the eye and of sensitive photographic preparations. Interesting results have also been obtained by Becquerel, whose method is founded upon a curious action of the ultra-red rays in enfeebling the light emitted by phosphorescent substances. One of the most startling of Langley's conclusions relates to the influence of the atmosphere in modifying the quality of solar light. By the comparison of observations made through varying thicknesses of air, he shows that the atmospheric absorption tells most upon the light of high refrangibility; so that, to an eye situated outside the atmosphere, the sun would present a decidedly bluish tint. It would be interesting to compare the experimental numbers with the law of scattering of light by small particles given some years ago as the result of theory. The demonstration by Langley of the inadequacy of Cauchy's law of dispersion to represent the relation between refrangibility and wave-length in the lower part of the spectrum must have an important bearing upon optical theory.

The investigation of the relation of the visible and ultra-violet spectrum to various forms of matter has occupied the attention of a host of able workers, among whom none have been more successful than my colleagues at Cambridge, Professors Liveing and Dewar. The subject is too large both for the occasion and for the individual, and I must pass it by. But, as more closely related to optics proper, I cannot resist recalling to your notice a beautiful application of the idea of Doppler to the discrimination of the origin of certain lines observed in the solar spectrum. If a vibrating body has a general motion of approach or recession, the waves emitted from it reach the observer with a frequency which in the first case exceeds, and in the second case falls short of, the real frequency of the vibrations themselves. The consequence is that, if a glowing gas be in motion in the line of sight, the spectral lines are thereby displaced from the position that they would occupy were the gas at rest—a principle which, in the hands of Huggins and others, has led to a determination of the motion of certain fixed stars relatively to the solar system. But the sun is itself in rotation, and thus the position of a solar spectral line is slightly different according as the light comes from the advancing or from the retreating limb. This displacement was, I believe, first observed by Thollon; but what I desire now to draw attention to is the application of it by Cornu to determine whether a line is of solar or atmospheric origin. For this purpose a small image of the sun is thrown upon the slit of the spectroscope, and caused to vibrate two or three times a second, in such a manner that the light entering the instrument comes alternately from the advancing and retreating limbs. Under these circumstances a line due to absorption within the sun appears to tremble, as the result of slight alternately opposite displacements. But if the seat of the absorption be in the atmosphere, it is a matter of indifference from what part of the sun the light originally proceeds, and the line maintains its position in spite of the oscillation of the image upon the slit of the spectroscope. In this way Cornu was able to make a discrimination which can only otherwise be effected by a difficult comparison of appearances under various solar altitudes.

The instrumental weapon of investigation, the spectroscope itself, has made important advances. On the theoretical side, we have for our guidance the law that the optical power in gratings is proportional to the total number of lines accurately ruled, without regard to the degree of closeness, and in prisms that it is proportional to the thickness of glass traversed. The magnificent gratings of Rowland are a new power in the hands of the spectroscopist, and as triumphs of mechanical art seem to be little short of perfection. In our own report for 1882, Mr. Mallock has described a machine, constructed by him, for ruling large diffraction gratings, similar in some respects to that of Rowland.

The great optical constant, the velocity of light, has been the subject of three distinct investigations by Cornu, Michelson, and Forbes. As may be supposed, the matter is of no ordinary difficulty, and it is therefore not surprising that the agreement should be less decided than could be wished. From their observations, which were made by a modification of Fizeau's method of the tooth wheel, Young and Forbes drew the conclusion that the

velocity of light *in vacuo* varies from colour to colour, to such an extent that the velocity of blue light is nearly two per cent. greater than that of red light. Such a variation is quite opposed to existing theoretical notions, and could only be accepted on the strongest evidence. Mr. Michelson, whose method (that of Foucault) is well suited to bring into prominence a variation of velocity with wave length, informs me that he has recently repeated his experiments with special reference to the point in question, and has arrived at the conclusion that no variation exists comparable with that asserted by Young and Forbes. The actual velocity differs little from that found from his first series of experiments, and may be taken to be 299,800 kilometres per second.

It is remarkable how many of the playthings of our childhood give rise to questions of the deepest scientific interest. The top is, or may be understood, but a complete comprehension of the kite and of the soap-bubble would carry us far beyond our present stage of knowledge. In spite of the admirable investigations of Plateau, it still remains a mystery why soapy water stands almost alone among fluids as a material for bubbles. The beautiful development of colour was long ago ascribed to the interference of light, called into play by the gradual thinning of the film. In accordance with this view the tint is determined solely by the thickness of the film, and the refractive index of the fluid. Some of the phenomena are, however, so curious as to have led excellent observers like Brewster to reject the theory of thin plates, and to assume the secretion of various kinds of colouring matter. If the rim of a wine-glass be dipped in soapy water, and then held in a vertical position, horizontal bands soon begin to show at the top of the film, and extend themselves gradually, downwards. According to Brewster these bands are not formed by the "subsidence and gradual thinning of the film," because they maintain their horizontal position when the glass is turned round its axis. The experiment is both easy and interesting; but the conclusion drawn from it cannot be accepted. The fact is that the various parts of the film cannot quickly alter their thickness, and hence when the glass is rotated they re-arrange themselves in order of superficial density, the thinner parts floating up over, or through, the thicker parts. Only thus can the tendency be satisfied for the centre of gravity to assume the lowest possible position.

When the thickness of a film falls below a small fraction of the length of a wave of light, the colour disappears and is replaced by an intense blackness. Professors Reinold and Rücker have recently made the remarkable observation that the whole of the black region, soon after its formation, is of uniform thickness, the passage from the black to the coloured portions being exceedingly abrupt. By two independent methods they have determined the thickness of the black film to lie between seven and fourteen millionths of a millimetre; so that the thinnest films correspond to about one-seventieth of a wave length of light. The importance of these results in regard to molecular theory is too obvious to be insisted upon.

The beautiful inventions of the telephone and the phonograph, although in the main dependent upon principles long since established, have imparted a new interest to the study of Acoustics. The former, apart from its uses in every day-life, has become in the hands of its inventor, Graham Bell, and of Hughes, an instrument of first-class scientific importance. The theory of its action is still in some respects obscure, as is shown by the comparative failure of the many attempts to improve it. In connection with some explanations that have been offered, we do well to remember that molecular changes in solid masses are inaudible in themselves, and can only be manifested to our ears by the generation of a to-and-fro motion of the external surface extending over a sensible area. If the surface of a solid remains undisturbed, our ears can tell us nothing of what goes on in the interior.

In theoretical acoustics progress has been steadily maintained, and many phenomena, which were obscure twenty or thirty years ago, have since received adequate explanation, If some important practical questions remain unsolved, one reason is that they have not yet been definitely stated. Almost everything in connection with the ordinary use of our senses presents peculiar difficulties to scientific investigation. Some kinds of information with regard to their surroundings are of such paramount importance to successive generations of living beings, that they have learned to interpret indications which, from a physical point of view, are of the slenderest character. Every day we are in the habit of recognising, without much difficulty, the quarter from which a sound proceeds, but by what steps we attain that end has not yet been satisfactorily explained. It has been proved that when proper precautions are taken we are unable to distinguish whether a pure tone (as from a vibrating tuning fork held over a suitable resonator) comes to us from in front or from behind. This is what might have been expected from an *à priori* point of view; but what would not have been expected is that with almost any other sort of sound, from a clap of the hands to the clearest vowel sound, the discrimination is not only possible, but easy and instinctive. In these cases it does not appear how the possession of two ears helps us, though there is some evidence that it does; and even when sounds come to us from the right or left, the explanation of the ready discrimination which is then possible with pure tones, is not so easy as might at first appear. We should be inclined to think that the sound was heard much more loudly with the ear that is turned towards than with the ear that is turned from it, and that in this way the direction was recognised. But if we try the experiment, we find that, at any rate with notes near the middle of the musical scale, the difference of loudness is by no means so very great. The wave-lengths of such notes are long enough in relation to the dimensions of the head to forbid the formation of anything like a sound shadow in which the averted ear might be sheltered.

In concluding this imperfect survey of recent progress in physics, I must warn you emphatically that much of great importance has been passed over altogether. I should have liked to speak to you of those far-reaching speculations, especially associated with the name of Maxwell, in which light is regarded as a disturbance in an electro-magnetic medium. Indeed, at one time, I had thought of taking the scientific work of Maxwell as the principal theme of this address. But, like most men of genius, Maxwell delighted in questions too obscure and difficult for hasty treatment, and thus much of his work could hardly be considered upon such an occasion as the present. His biography has recently been published, and should be read by all who are interested in science and in scientific men. His many-sided character, the quaintness of his humour, the penetration of his intellect, his simple but deep religious feeling, the affection between son and father, the devotion of husband to wife, all combine to form a rare and fascinating picture. To estimate rightly his influence upon the present state of science, we must regard not only the work that he executed himself, important as that was, but also the ideas and the spirit which he communicated to others. Speaking for myself as one who in a special sense entered into his labours, I should find it difficult to express adequately my feeling of obligation. The impress of his thoughts may be recognised in much of the best work of the present time. As a teacher and examiner he was well acquainted with the almost universal tendency of uninstructed minds to elevate phrases above things; to refer, for example, to the principle of the conservation of energy for an explanation of the persistent rotation of a fly-wheel, almost in the style of the doctor in "Le Malade Imaginaire," who explains the fact that opium sends you to sleep by its soporific virtue. Maxwell's endeavour was always to keep the facts in the foreground, and to his influence, in conjunction with that of Thomson and Helmholtz, is largely due that elimination of unnecessary hypothesis which is one of the distinguishing characteristics of the science of the present day.

In speaking unfavourably of superfluous hypothesis, let me not be misunderstood. Science is nothing without generalisations. Detached and ill-assorted facts are only raw material, and in the absence of a theoretical solvent, have but little nutritive value. At the present time and in some departments, the accumulation of material is so rapid that there is danger of indigestion. By a fiction as remarkable as any to be found in law, what has once been published, even though it be in the Russian language, is usually spoken of as "known," and it is often forgotten that the rediscovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory. In this matter we are greatly dependent upon annual reports and abstracts, issued principally in Germany, without which the search for the discoveries of a little-known author would be well-nigh hopeless. Much useful work has been done in this direction in connection with our Association. Such critical reports as those upon hydrodynamics, upon tides, and upon spectroscopy, guide the investigator to the points most requiring attention, and in discussing past achievements contribute in no small degree to future progress. But though good work has been done, much yet remains to do.

If, as is sometimes supposed, science consisted in nothing but the laborious accumulation of facts, it would soon come to a standstill, crushed, as it were, under its own weight. The suggestion of a new idea, or the detection of a law, supersedes much that had previously been a burden upon the memory, and by introducing order and coherence facilitates the retention of the remainder in an available form. Those who are acquainted with the writings of the older electricians will understand my meaning when I instance the discovery of Ohm's law as a step by which the science was rendered easier to understand and to remember. Two processes are thus at work side by side, the reception of new material and the digestion and assimilation of the old; and as both are essential, we may spare ourselves the discussion of their relative importance. One remark, however, should be made. The work which deserves, but I am afraid does not always receive, the most credit is that in which discovery and explanation go hand-in-hand, in which not only are new facts presented, but their relation to old ones is pointed out.

In making oneself acquainted with what has been done in any subject it is good policy to consult first the writers of highest general reputation. Although in scientific matters we should aim at independent judgment, and not rely too much upon authority, it remains true that a good deal must often be taken upon trust. Occasionally an observation is so simple and easily repeated, that it scarcely matters from whom it proceeds; but as a rule it can hardly carry full weight when put forward by a novice whose care and judgment there has been no opportunity of testing, and whose irresponsibility may tempt him to "take shots," as it is called. Those who have had experience in accurate work know how easy it would be to save time and trouble by omitting precautions and passing over discrepancies, and yet, even without dishonest intention, to convey the impression of conscientious attention to details. Although the most careful and experienced cannot hope to escape occasional mistakes, the effective value of this kind of work depends much upon the reputation of the individual responsible for it.

In estimating the present position and prospects of experimental science, there is good ground for encouragement. The

multiplication of laboratories gives to the younger generation opportunities such as have never existed before, and which excite the envy of those who have had to learn in middle life much that now forms part of an undergraduate course. As to the management of such institutions there is room for a healthy difference of opinion. For many kinds of original work, especially in connection with accurate measurement, there is need of expensive apparatus; and it is often difficult to persuade a student to do his best with imperfect appliances when he knows that by other means a better result could be attained with greater facility. Nevertheless it seems to me important to discourage too great reliance upon the instrument maker. Much of the best original work has been done with the homeliest appliances; and the endeavour to turn to the best account the means that may be at hand develops ingenuity and resource more than the most elaborate determinations with ready-made instruments. There is danger otherwise that the experimental education of a plodding student should be too mechanical and artificial, so that he is puzzled by small changes of apparatus much as many school-boys are puzzled by a transposition of the letters in a diagram of Euclid.

From the general spread of a more scientific education, we are warranted in expecting important results. Just as there are some brilliant literary men with an inability, or at least a distaste practically amounting to inability, for scientific ideas, so there are a few with scientific tastes whose imaginations are never touched by merely literary studies. To save these from intellectual stagnation during several important years of their lives is something gained; but the thorough-going advocates of scientific education aim at much more. To them it appears strange, and almost monstrous, that the dead languages should hold the place they do in general education; and it can hardly be denied that their supremacy is the result of routine rather than of argument. I do not, myself, take up the extreme position. I doubt whether an exclusively scientific training would be satisfactory; and where there is plenty of time and a literary aptitude I can believe that Latin and Greek may make a good foundation. But it is useless to discuss the question upon the supposition that the majority of boys attain either to a knowledge of the languages or to an appreciation of the writings of the ancient authors. The contrary is notoriously the truth; and the defenders of the existing system usually take their stand upon the excellence of its discipline. From this point of view there is something to be said. The laziest boy must exert himself a little in puzzling out a sentence with grammar and dictionary, while instruction and supervision are easy to organise and not too costly. But when the case is stated plainly, few will agree that we can afford so entirely to disregard results. In after life the intellectual energies are usually engrossed with business, and no further opportunity is found for attacking the difficulties which block the gateways of knowledge. Mathematics, especially, if not learned young, are likely to remain unlearned. I will not further insist upon the educational importance of mathematics and science, because with respect to them I shall probably be supposed to be prejudiced. But of modern languages I am ignorant enough to give value to my advocacy. I believe that French and German, if properly taught, which I admit they rarely are at present, would go far to replace Latin and Greek from a disciplinary point of view, while the actual value of the acquisition would, in the majority of cases, be incomparably greater. In half the time usually devoted, without success, to the classical languages, most boys could acquire a really serviceable knowledge of French and German. History and the serious study of English literature, now shamefully neglected, would also find a place in such a scheme.

There is one objection often felt to a modernised education, as to which a word may not be without use. Many excellent people are afraid of science as tending towards materialism. That such apprehension should exist is not surprising, for unfortunately there are writers, speaking in the name of science, who have set themselves to foster it. It is true that among scientific men, as in other classes, crude views are to be met with as to the deeper things of Nature; but that the life-long beliefs of Newton, of Faraday, and of Maxwell, are inconsistent with the scientific habit of mind, is surely a proposition which I need not pause to refute. It would be easy, however, to lay too much stress upon the opinions of even such distinguished workers as these. Men, who devote their lives to investigation, cultivate a love of truth for its own sake, and endeavour instinctively to clear up, and not, as is too often the object in business and politics, to obscure a difficult question. So far the opinion of a scientific worker may have a special value; but I do not think that he has a claim, superior to that of other educated men, to assume the attitude of a prophet. In his heart he knows that underneath the theories that he constructs there lie contradictions which he cannot reconcile. The higher mysteries of being, if penetrable at all by human intellect, require other weapons than those of calculation and experiment.

Without encroaching upon grounds appertaining to the theologian and the philosopher, the domain of natural science is surely broad enough to satify the wildest ambition of its devotees. In other departments of human life and interest, true progress is rather an article of faith than a rational belief; but in science a retrograde movement is, from the nature of the case, almost impossible. Increasing knowledge brings with it increasing power, and great as are the triumphs of the present century, we may well believe that they are but a foretaste of what discovery and invention have yet in store for mankind. Encouraged by the thought that our labours cannot be thrown away, let us redouble our efforts in the noble struggle. In the Old World and in the New, recruits must be enlisted to fill the place of those whose work is done. Happy should I be if, through this visit of the Association, or by any words of mine, a larger measure of the youthful activity of the West could be drawn into this service. The work may be hard, and the discipline severe; but the interest never fails, and great is the privilege of achievement.

ON GLOBULAR LIGHTNING.

By M. GASTON PLANTÉ.

I DESCRIBED, some years ago, under the name of the *travelling electric spark*, a peculiar phenomenon produced by the passage of an electric current of high tension. If we place a condenser, with a very slender mica plate, in communication by means of its two plates, with the electrodes of a secondary battery of 800 elements, the condenser may be perforated by reason of the high tension of the current, and as under these conditions the quantity is much greater than with a source of static electricity, the effect is not limited to the production of a spark; there is formed a small incandescent globule in consequence of the fusion of the matter of the condenser itself, and this globule moves slowly along its surface, following the points where the insulating material which separates the plates presents the least resistance, and describing the most capricious windings.

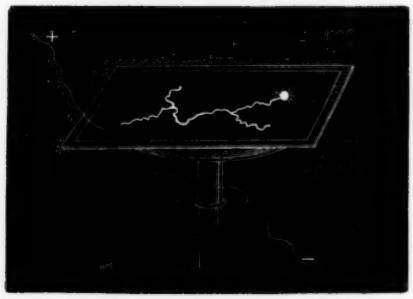


FIG. 1.

The experiment may last one or two minutes; it ceases only when the battery has discharged itself, so that the globule can no longer remain in a state of fusion between the two plates.

The slow movement of this little globule is attended with a loud roaring, and when the condenser is rendered adherent to the surface of a plate of hard caoutchouc, there is heard an acute, strident sound, similar to that which is produced when a sheet of metal or of paste-board is sawn or torn by a toothed wheel moving at a great speed. The condenser is at the same time, so to speak, sawn and cut through on the whole track of the ignited globule.

I have pointed out the analogy of these effects with those of globular lightning. The better to imitate the conditions under which the natural phenomenon is produced, I have latterly increased the tension of the source of dynamic electricity, bringing into play the current of a secondary battery of 1,600 elements, the electromotive force of which, at the first moments of the discharge, is about 4,000 volts. Suppressing, on the other hand, the plate of mica and the metallic plates, since in the atmosphere there are merely masses of air and of watery vapour, I operated simply with moist electrified surfaces, separated by a stratum of air. These humid surfaces were formed of plugs or discs of filter-paper, moistened with distilled water.

When this system is connected with the poles of the battery, we see appear a small ball of fire, which runs from side to side between the two surfaces, and for some minutes presents spontaneous intermittences in its appearance and disappearance. As the battery is thus discharged less rapidly than between metallic plates, the experiment lasts longer. The inter-

mittences are due to the circumstance, that when the globule of fire dries various points of the damp surface in consequence of the heat which it produces, and causes the watery vapour to disappear, the presence of which diminishes the resistance of the interval between the surfaces, the current is interrupted at these points, but the effect reappears then at other points which have remained moist.

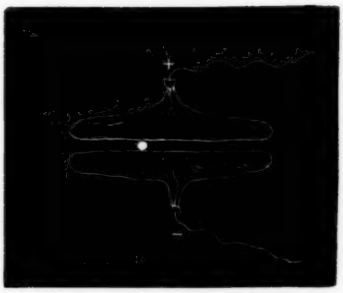


FIG. 2.

These experiments seem to me to confirm the explanations which I have already given concerning globular lightning, and I think I may now conclude with more certainty that globular lightning is a slow and partial discharge, whether direct, or by influence, of the electricity of storm-clouds, when such electricity is exceptionally plentiful in quantity, and when the cloud itself, or the column of moist air strongly electrised which forms, so to speak, the electrode is very near to the ground, so as almost to reach it, being separated merely by a thin stratum of insulating air.

Under these conditions the electric flux, in consequence of its abundance, or more strictly the ponderable matter which it traverses, collects, as in the experiments just described, in the form of a globe of fire. It is, in some degree, an *electric egg*, without a glass cover, formed of the elements of the air and the watery vapour rarified and incandescent. This globe does not constitute a kind of bomb charged with electricity; it is not fulminating and dangerous in itself, as is proved by the curious narratives of Babinet and other observers; for the slightest current of air suffices to displace it, as in the experiments above mentioned a slight blast drives away the globule, or occasions it to disappear for the moment. Its presence is nevertheless formidable, for it brings the electricity from the storm-cloud with which it communicates in a latent manner, or sometimes visibly, as at the extremity of water-spouts, and shows the place which it selects for its efflux.

If the stratum of air which separates the cloud from the soil is not perforated, the globe of fire may disappear without noise, as is often observed; or if a portion of the storm-cloud sinks towards the earth at another point, the lightning may fall further off at the same time as the globe disappears. But if the stratum of air is perforated, there naturally results a fall of lightning at the very point where the globe appeared, accompanied by the sound of thunder, and derived, not from the small quantity of electricity contained in the small mass of rarified and luminous air forming the globe, but from the sudden discharge of the whole, or a great part of the electricity contained in the storm-cloud.

The slow and capricious movement of these lightning globes is explained, like that of the electric globules of fire produced in the experiments described above, by the variations in the resistance of the stratum of air which separates them from the soil, and by the natural tendency of the electric flux to seek the line of least resistance for its escape to the earth.

As for the globes of fire which sometimes appear in the midst of the clouds themselves, in violent storms, of which Arago has related several instances, the above-mentioned experiment (fig. 2) offers the exact image on a very reduced scale, and the sight of it enables us to give an account of the natural phenomenon.

Thus may be explained the different effects of globular lightning, or "thunder balls," which seemed an enigma as long as they were compared only with the effects of an apparatus of static electricity, in which the quantity of electricity in action is too trifling to present analogous phenomena, but which, on the contrary, become easy to understand on comparing them with the effects produced by a source of dynamic electricity, combining quantity and tension.—*Comptes Rendus.*

[We are indebted to the courtesy of M. Gaston Planté for the blocks wherewith to illustrate his interesting article.—EDS. ELEC. REV.]

INTERRUPTION OF A CURRENT WITHOUT PRODUCING SPARKS.

M. A. GRAVIER.

TO interrupt the passage of the current from any source whatever, in an external circuit, it is sufficient to close the current upon itself. The solution is general and is known to all electricians. As a particular case we will indicate its application to machines generating electromotive force.

1. Machine with direct-excitation (fig. 1).

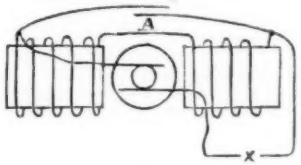


FIG. 1.

2. Machine with derived excitation (fig. 2).

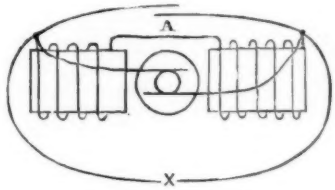


FIG. 2.

Close at A.

The solution is the same for the machine with double excitation (system of Deprez).

This solution is not the only one; we may also interrupt the current of a machine by reversing the exciting current in one of the two field-magnets; the polarities of the magnetic-field become of the same sign and the production of the current ceases immediately.

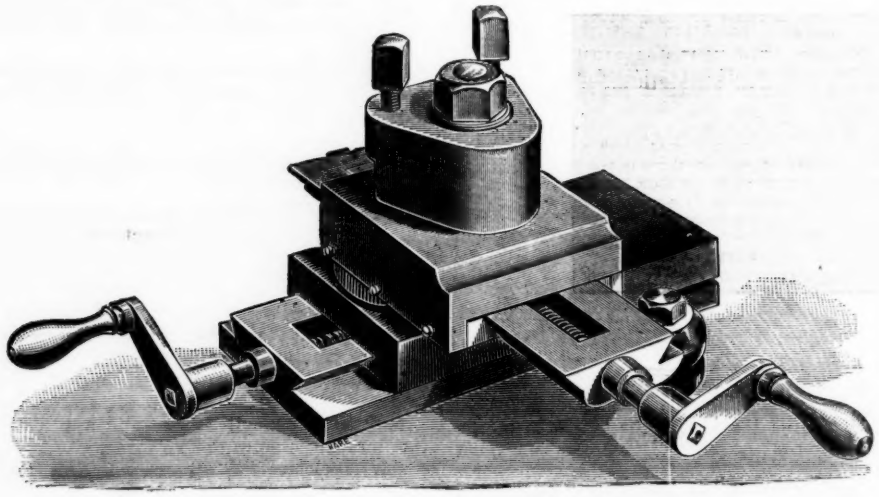
There is a third solution, original and hitherto unpublished, which consists in closing the magnetic circuit of a dynamo upon itself.

For the special case of a machine with direct-excitation, we may instantly arrest the production by making the connections, as if for a motor, by means of a commutator.—*Bulletin de la Société Internationale des Electriciens*

Fletcher's Patent Gas-tight India Rubber Tubing.—Mr. Thomas Fletcher, of Warrington, announces that he has succeeded in making an elastic rubber tube, perfectly gas-tight, and free from smell under all conditions. The tube is formed of two separate layers of rubber, with a film of soft pure tin foil vulcanised between.

NEW PATTERN COMPOUND SLIDE REST.

THE engraving represents the latest improvement in lathe rests effected by the Britannia Company, which apparatus may be of some interest to those of our readers who are manufacturers. The construction is such that the bottom slide always remains at right angles with the lathe bed. It is provided with a swivel arrangement, and is accurately graduated for turning taper or conical work to any desired angle. The bottom cover extending the full length excludes turnings and dirt from the screw and slide. The screws are of cast steel, gun metal nuts, horn handles, and wrought iron tool box with hardened steel screw. The slides, &c., are surfaced up, and the parts, being machine-made and uniform, are interchangeable. Included with each rest is a double spanner. The tool-holder is of the most approved design, with ample strength to secure a firm grip of the tool.

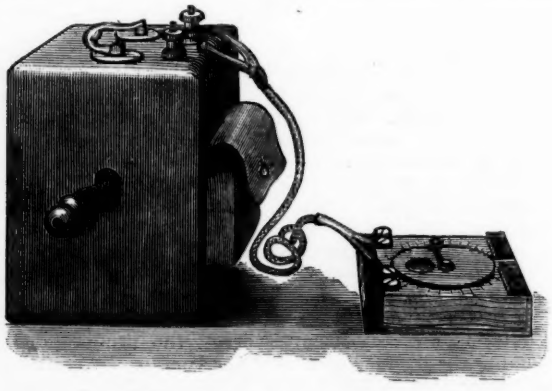


Other patterns of tool-holders can be made to order, but experience proves that, when made with due regard to the heavy strain put upon them, there is no handier or more efficient pattern than the above.

APPARATUS FOR TESTING THE RESISTANCE OF LIGHTNING RODS.

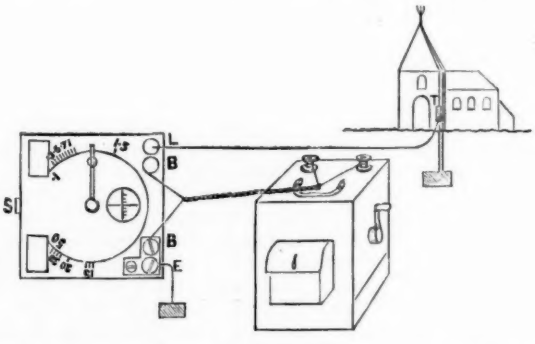
[A COMMUNICATION.]

THIS apparatus constructed by Messrs. Siemens Bros. consists of a magneto-inductor contained in a wooden box, and a small bridge-board sliding into a recess at the bottom of the box. To the latter are affixed a German silver ring, a pointer, which also acts as a battery key, a small galvanometer, four terminals, marked L, B, B, E, and beneath the board a constant resistance. The weight of the apparatus is 8½ lbs. It is advisable, when erecting a lightning-rod, that a loose copper wire be connected to the point of same, running down parallel with it to the base. A connection may then be made to this, which would save the trouble of climbing up to the point* each time the lightning-rod had to be tested.



For economy sake, when erecting a lightning-rod two ropes †, having the same sectional area as the single rope intended to be fitted might be used, both of them being connected to the earth-plate and acting as a single conductor. One of the ropes could then have a connection screw fitted at the base, T, so that it could be disconnected from earth for testing as required.

When a lightning-rod is to be tested, terminal L has to be connected to the point of the rod or the loose wire below; terminal E to a reliable earth, and terminals B, B, to the inductor. Then, by turning the inductor handle and pressing down the pointer on the board, a current is sent through the bridge, and if a deflection be shown on the galvanometer, the pointer (being still pressed down) must be turned to the left or right until the needle stands at zero. The graduations round the ring have been so arranged, that in this position the pointer will stand at the figure corresponding to the resistance in ohms of the lightning-rod and its earth connection.



* Vyle's lightning-rod is constructed to meet these requirements.—[EDS. ELEC. REV.]

† This is precisely the same as that proposed by "Musicus," in the REVIEW for January 12th of the present year.—[EDS. ELEC. REV.]

The board must be so turned before the test is made that the needle of the galvanometer swings freely and stands at zero, and it must be placed as far from the inductor as the leading wire supplied with the instrument will allow, that the galvanometer may not be affected by the magnetism of the magnets in the inductor. There is a small brass slide, S, at the back of the bridge-board, which by withdrawing sets the needle into action, and by pushing in lifts it off again. When measuring higher resistances, the screw marked "ten-fold" must be taken out, the instrument will then measure ten-fold the resistances marked on it, *i.e.*, from 1 up to 500 ohms.

Measurements made on the lightning-conductor on Messrs. Siemens Brothers large factory shaft, which is 135 feet high, gave the following results:—When measured from its own earth-plate, less than 0·1 ohm; taking gas pipe for earth, 5·3 ohm; taking water pipe for earth, 0·6 ohms.

G. R.

[From a casual glance this apparatus would seem to be similar to that devised by Mr. Walker, and which was briefly described by us in our last week's issue, but it is actually an improvement on that instrument.—EDS. ELEC. REV.]

THE RELATIVE SIZE OF A MOTOR AND ITS DRIVING DYNAMO.

WHEN a motor and dynamo (of similar construction) are placed in the same circuit, the weight of the dynamo to that of the motor should bear a constant proportion with each type of machine.

When the resistances L, R, and r, of the line, field-magnet coil and armature respectively, are so adjusted to each other that the motor worked as a dynamo produces the most economical amount of work, then the current produced with the field-magnet in direct circuit will be

$$c = \frac{\sqrt{r}}{L + R + r}$$

since $\sqrt{r}$ is proportional to the length of conductor on the armature which varies with the electromotive force.

When the motor works most efficiently, a current strength equal to this value of c must be sent through the motor, while it is allowed to rotate backwards with the same velocity.

Since the same current strength will circulate through the armature and field-magnet of the dynamo as through that of the motor, it is necessary that the sectional area of the conductors of the dynamo should be the same as those of the motor, and therefore the resistances of the armature and field-magnet of the dynamo will be proportional to their weight, so that if w_1 equals the weight of the dynamo and w the weight of the motor, the electromotive force, resistance of armature and resistance of field-magnet of dynamo will be $\frac{w_1}{w}\sqrt{r}$, $\frac{w_1}{w}r$, and $\frac{w_1}{w}R$ respectively.

and when the dynamo produces a current equal to that produced by the motor

$$c = \frac{\frac{w_1}{w}\sqrt{r} - \sqrt{r}}{L_1 + (R + r)\frac{w_1}{w} + R + r}$$

$$\therefore \quad \frac{\sqrt{r}}{L + R + r} = \frac{\frac{w_1}{w}\sqrt{r} - \sqrt{r}}{L_1 + (R + r)\frac{w_1}{w_1} + R + r}$$

$$\therefore \quad L_1 + (R + r)\frac{w_1}{w} + R + r = (L + R + r)\frac{w_1}{w} - (L + R + r)$$

$$\therefore \quad L_1 + L + 2(R + r) = L\frac{w_1}{w}$$

$$\therefore \quad w_1 = w\frac{L_1 + L + 2(R + r)}{L}$$

The fraction of the work expended on the dynamo that is given out by the motor is equal to the dividend of their electromotive forces, since the current flowing through each is the same, and is therefore equal to

$$\frac{w}{w_1} = \frac{L}{L_1 + L + 2(R + r)};$$

it is therefore obvious that the work realised in the motor would be small unless L is large compared with L_1 and with $2(R + r)$; to make L large compared with L_1, the resistances R and r should be made as great as possible since L, R and r vary as each other when the dynamo produces a constant amount of work in the circuit; so that R and r should be made as great as the increase of electromotive force of the machines will permit.

If the dynamo and motor have their field-magnets in derived instead of in direct circuit, then the proportion of w_1 to w would be the same as when the field-magnets were in direct circuit, and the two methods would be equally economical if the armatures and field-magnets have their resistances readjusted. The resistances r_1 and R_1 of the armature and field-magnet of the dynamo with derived circuit field-magnet, in terms of the resistances $r\frac{w_1}{w}$ and $R\frac{w_1}{w}$ of the direct circuit field-magnet dynamo, would be of similar value to those given in the ELECTRICAL REVIEW of June 9th, 1883 for a dynamo working in a circuit without a motor, namely

$$r_1 = \frac{w_1}{w}\, r \left(\frac{L}{L + R}\right)^2$$

and

$$R_1 = \frac{w_1}{w}\frac{L^2}{R}.$$

But the resistance of the armature and field-magnet of the motor with derived circuit field-magnet in terms of the resistances of the armature and field-magnet of motor, with direct circuit field-magnet, would be different from the preceding values, and may be thus determined:—

Let v be the potential at the junction of the line and the motor, then, since the current that flows through the motor should be equal to that which the motor sends when it itself is working as a dynamo

$$\therefore \quad \frac{v - \sqrt{r}}{R + r} = \frac{\sqrt{r}}{L + R + r}$$

$$\therefore \quad v = \sqrt{r}\,\frac{L + 2(R + r)}{L + R + r}$$

this value of v must be the same in both direct and derived systems, for then the total energy spent in the motors will be constant since $v\,c$ is constant.

Let r_2 and R_2 be the resistances of the armature and field-magnet of the motor with derived circuit field-magnet, then, when the current in the armature multiplied by the lengths of the conductors are the same in both direct and derived systems,

$$\frac{v - \sqrt{r_2}}{r_2}\sqrt{r_2} = \frac{\sqrt{r}}{L + R + r}\sqrt{r}$$

by filling in the preceding value of v and reducing

$$r_2 = r\left(\frac{L + 2(R + r)}{L + R + 2r}\right)^2,$$

also in the field-magnet

$$\frac{v}{R_2}\sqrt{R_2} \text{ must equal } \frac{\sqrt{r}}{L + R + r}\sqrt{R},$$

by filling in the value of v and reducing

$$R_2 = \frac{1}{R}(L + 2(R + r))^2.$$

Although the direct and derived circuit motors are equally economical, the direct circuit motor, besides

having the advantage of having its dimensions more readily calculated, has also the advantage of greater steadiness, since, when the force opposing the motion of the armature of the motor is increased, the increase of current through the field-magnet and armature, resulting from the decrease of velocity, increases the pull of the armature and tends to make the work performed by the motor constant, but when the field-magnet of the motor is in derived circuit, any decrease of the velocity of the armature decreases the current flowing through the field-magnet, and although the current through the armature is increased the pull of the armature is decreased; so that any variation of the load of a motor with a derived circuit field-magnet causes a greater variation of the speed and the work performed than is the case with a motor with its field-magnet in direct circuit.

W. MOON.

THE ORGANISATION OF THE POST AND TELEGRAPH SERVICE IN FRANCE.

(*Continued from page* 151.)

THE financial department, composed of the following sections—receiving, issue and payment of post-office orders, complaints, savings' banks, registration of newspapers, printed matter, samples, recovery of outstanding debts, and *poste restante*—is in direct communication with the public, and this department also has the full control of the books and accounts of the post and telegraphs of the department of Paris and La Seine.

The offices are open from 8 o'clock in the morning until 8 o'clock at night, except for the registration of newspapers, which begins at 3 o'clock in the morning, and the office for *poste restante*, which does not close until 10 o'clock at night.

A great many publishers of newspapers often bring their publications from long distances to the central office. Heaps of prospectuses are handed in by commercial houses; a large number of merchants resort to it in order to take advantage of the last moment allowed for posting letters, which is later at the central post office than at the other offices.

In order to meet such a heavy strain the work at the central post office is permanent. From 4 o'clock in the morning postmen and carriers are busy preparing the first delivery of letters. The last delivery does not finish until 9 o'clock at night. The special service of delivery, therefore, lasts 17 hours without interruption. The forwarding service takes place day and night. The day staff consists of 1,595 clerks and carriers, and the night staff of 1,400.

These figures show that the central post office is the centre where the whole postal traffic of Paris and a large part of that of the country converge.

It is, therefore, essential that it should be properly arranged so as to meet all the exigencies of the service. For a long while the central post office has been badly fitted out. It only disposed of a building, bought more than a century ago, which originally had not been intended for such work, and the insufficiency of it had been pointed out, since the year 1800. This was remedied in a very feeble and insufficient manner by the successive annexation of adjacent buildings, but their internal distribution and the different heights of the floors badly suited the exigencies of the service.

The question of removing the central post office has been agitated on several occasions. Under the first Empire it was to be rebuilt in the Rue de Rivoli, but the site intended for it has been occupied by the Ministry of Finances. In 1856 a convention was signed with the Prefect de la Seine to remove it to the Place du Châtelet. This project was not realised. There was also some talk of transferring the central post office to the Cours-la-Reine and the Rue Saint-Honoré, on the site of the Chappel of the Assumption (1864). None of these projects came to anything, either because of the Chambers not agreeing to grant the necessary funds, or because of the selected site being very much criticised.

The situation, however, became worse and worse. All possible expedients had been made use of to assure, even under insufficient conditions, the good working of the service. The defective installation prejudiced the regularity of the work and the health of the clerks, who were in need of room and even of air to breathe. The slightest incident caused nearly insurmountable difficulties, increased the already very heavy work of the staff, and rendered them liable to make mistakes, which always are to be regretted.

A settlement of this question was rendered more and more urgent, because of the enormous increase in the number of objects of correspondence, following the reduction of rates in 1878.

The situation was thus summed up in the remarkable report of M. Spuller, which was presented to the Supreme Commission of Municipal Buildings and National Palaces.

"Urgency is extreme. The postal service in Paris is in the most deplorable condition. This Administration, the development of which becomes every day more extensive, calls for the immediate attention of the public powers.

"No reform, no serious improvement is possible, or even can be attempted, in the present condition of the premises. In every part of the building there is danger of fire. The employés have to do their work under conditions of unhealthfulness and inconvenience to such a degree as to render inexplicable the care and the zeal with which they acquit themselves of their task. Such as it is, in the state of decay, dilapidation, and meanness, where it shows itself to strangers, the central post office is a disgrace to transformed Paris."

Two solutions presented themselves; one consisted of establishing the central postal office in the Palace of the Quai d'Orsay, previously occupied by the Council of State and the Court of the Exchequer; the other, of partly rebuilding it on its old site at the corner of the Rue Etienne-Marcel and the Rue du Louvre, the opening of which was delayed this great while.

This latter solution offered the advantage of keeping the central post office in the centre of business, within a few steps from the Stock Exchange, the bank, and the markets. It has become possible to adopt it, owing to an agreement with the City of Paris, which has undertaken to clear the approaches to the new central post office, and to improve the distribution of streets in this quarter.

We have asked the Chambers, in 1879, for the funds required for this re-building, and their vote has allowed of rapidly carrying on the work of the new office, which we hope will be completed towards the end of this year.

Nothing has been omitted to make it a building that can keep pace with postal progress. Mr. Guadet, the architect under whose supervision the work is being carried out, has been sent on a special mission both to England and Germany, to study there the most recent improvements introduced in similar buildings of first rank, and we feel sure that the principal postal establishment in France will be worthy of her and her capital.

The new building will occupy an area of about 7,800 square metres. The whole of the serviceable area, including therein the upper floors, will not be less than 23,000 square metres; whilst the corresponding area in the old building was not more than 8,000 square metres.

The comparison of those two figures only makes evident part of the improvements which the service will obtain from building this new office. The old installation involved loss of time to the employés, far removed from each other, and working in separate rooms, which were by no means adequate for such kind of work.

In the new office the galleries will be spacious, and arranged with a view to their special destination. Superintendence will be easy, and loss of time will also be diminished.

On the other hand, the plans have been devised to satisfy a tenfold traffic of that which existed at the time they have been agreed on. In this respect future appears to be well provided for.

At the request of the Commission of the Senate, that part of the ground of the old central post office which was not required for building the new office, or for roads to be opened, has been reserved. This space, the use of which up to the present has not been settled, allows of providing against all contingencies.

A use for it, however, may be found if, as we hope, the happy thought of the metropolitan railway is realised, and allows of using this road to bring the travelling offices up to the central post office. The transferring of the post-bags could then be executed direct. The result of this would be a remarkable acceleration, by doing away with the carriage-journeys between the post office and the railway stations, through particularly crowded thoroughfares.

Improved machines and engines, such as lifts, little trucks on rails, &c., will allow of simplifying and accelerating all the transfers to the difierent parts of the building.

During the building of the new central post office this service has been installed in barracks, situated on the north side of the Place du Carrousel.

The transfer of this extensive and complicated service took place in the night of the 8th August, 1880, without causing any interruption or any inconvenience in the work of the central post office.

The central telegraph station is to the telegraph service what the central post office is to the postal service. It is the large centre, where all telegraph messages converge exchanged between Paris, the country, and with foreign countries, as well as a great number of those exchanged between different towns.

The central telegraph station is exclusively a transmitting office. No messages are received from the public, and none are delivered direct.

There is a day and night service, without interruption. It is divided into two parts; in one the work is done by clerks, in the other by women. Two staffs of clerks, alternating each day, are on duty, one from 7 a.m. in the summer and from 8 a.m. in the winter till 11 a.m., and from 6 p.m. to 9 p.m.; the other from 11 a.m. till 6 p.m. The hours of the female clerks are arranged in the same manner, only they are as follows: from 6.45 a.m. in the summer, and from 7.45 a.m. in the winter till 10.30 a.m., and from 5.30 p.m. till 9.15 p.m.; or from 10.30 a.m. till 5.30 p.m. The night duty is performed, according to a fixed rotation, by clerks who receive extra payment for this additional work.

As regards the staff, the service of the central telegraph station is under the supervision of the "receveur," chief of the station, at present assisted by four superintendents and assistant-superintendents, and 72 senior clerks.

The number of clerks who work the instruments, which in 1877 was 360, amounted in 1883 to 451.

The considerable increase in the number of messages, in consequence of the reduction of telegraph rates, necessitated a large

augmentation of the staff. The working of instruments by women, which was tried in 1877, and which has given good results, has received a great extension within the last five years. At present, 404 women are engaged in the service of the central telegraph station.

The staff further consists of 16 special employés or instrument-makers, who look after and repair the instruments; 6 batterymen, 14 tube-assistants, who work the pneumatic tubes.

The internal service of the office (stamping the forms, distributing and collecting the messages from the instruments) is performed by 75 employés, called "coulistes."

The central telegraph station was pinched for room in the numerous rooms of the old office. In order that the work may be well performed and quickly executed, that messages be not delayed, we require spacious galleries specially fitted for such service. A new building has been constructed for that purpose. It contains on the entresol the gallery for female clerks, and on the first floor that for men. The area utilised by the central telegraph station and its annexes, which previously was only 3,100 square metres, now amounts to 4,750 square metres.

The necessity of uniting in adjoining rooms the services of the Central Administration of the Ministry, partly installed in the old central post office, also required the construction of new buildings in the Rue de Grenelle, No. 99.

The continually increasing development of telegraphic correspondence compelled us to prepare for an eventual extension of the central telegraph station.

This is foreseen by a project, the principle of which has already been adopted by the Chambers. This project will allow of building in the court of the High School of Telegraphy two spacious rooms or galleries, each with an area of 2,850 square metres, and where the new instruments, which may be required through the extension of the work, can be placed.

The use of the electric light, by way of trial, in the new galleries of the central telegraph station, has proved that this system of lighting was less fatiguing to the sight of the employés and improved the material conditions of performing their work.

We have made the use of it definite. The system adopted is that of Mr. Cance. It has appeared to us to answer best to the special wants and wishes of the staff. The use of the electric light will also be considered for the large galleries of the new central post office.

The new installation allows of making use, on a large scale, of Humblot's turbines to work the Hughes instruments. Winding up the weight of this instrument (60 kilos) was too troublesome for women. This material difficulty overcome, working the instrument has become easy to them.

The following are the telegraph instruments in use at the central telegraph station:—8 Baudots; 1 quadruple Meyer, working simultaneously with Caen and Cherbourg; 6 Wheatstone (in 1877 there were only two); 125 Hughes (in 1877 the number was 76); 277 Morses (119 in 1877).

The batteries are kept in the cellars of the central station. In 1877 they consisted of 4,150 Marié-Davy cells and 4,264 Callaud cells, or a total of 8,394 cells. Owing to the adopted manner of connecting them up we have been able, since 1878, to do away with the most expensive cells, and to do the work with 6,340 cells, which have proved to be sufficient for the requirements of the service, notwithstanding the number of wires ending in the central station has increased from 122 to 360.

The total amount of its traffic includes the telegrams to and from the offices in Paris, as well as the messages to and from the departments or abroad, which pass through the central station.

The transits traffic of this office, which 1877 was 5,300,700 telegrams, amounted in 1883 to 13,657,131, or an increase of 8,356,431 telegrams, equal to 157 per cent.

The daily average has therefore passed from 14,700 to 40,000 messages; it often reaches and exceeds 45,000 transmissions.

A telegraph office of an equally exceptional importance is that of the stock exchange; it occupies the rooms of the old tribunal of commerce. This is the telegraph office, the receipts of which are the highest; during the hours of the stock exchanges, 16 "guichets" can be opened to the public.

Its situation in the centre of the pneumatic system renders it the transit office of the greater part of the messages from Paris to Paris.

The service here, like at the central station, is permanent and divided between clerks and women.

This office shares with the central station, although to a less extent, the communications with the country and abroad. The staff consists of one director, two assistant superintendents, eleven senior clerks, 116 clerks, 70 women, two special employés or instrument makers, 13 tube assistants, 34 "coulistes," and 73 distributors. The instruments are 40 Morses, and 29 Hughes.

The batteries at the stock exchange include 1,824 Callaud cells, and 110 Marié-Davy cells, large size. The number of urban wires which end at present in this office amounts to 44.

Besides this office is in constant communication with London with six wires, and with Brussels with one wire. At the hours of the stock exchanges it further disposes of another wire with London, and of one wire with each of the stock exchanges in Berlin, Vienna, Francfort, Brussels, Antwerp, Geneva, Amsterdam, of one wire with Bordeaux, and of two wires with the central station in Lyons.

As regards the total traffic of the office in the Stock Exchange, which in 1877 was 2,110,019 telegrams, it amounted in 1883, to 3,498,082, or an increase of 1,388,063 telegrams, equal to 65 per cent.

The following table shows the telegraph receipts of this office:—

YEARS.	Inland Rates. Francs.	Foreign Rates. Francs.	Total Receipts. Francs.
1877	549,307·10	1,658,620·45	2,207,927·55
1878	603,228·50	1,823,138·90	2,426,367·40
1879	567,244·75	1,926,532·75	2,493,777·50
1880	651,432·80	2,312,507·62	2,963,940·42
1881	957,415·02	2,977,028·24	3,934,443·26
1882	741,595·35	2,331,066·61	3,072,661·96
1883	598,399·10	2,217,853·43	2,816,252·53

The receipts of 1883, as compared with those of 1877, therefore show an increase of 608,334 francs, or 27 per cent.

The central station of the Rue de Grenelle is in direct communication with 22 foreign towns; with several of those towns, namely, London, Berlin, Vienna, &c., there exist multiple communications.

220 French towns, 72 of which are principal towns of departments, are connected with the central station by means of 216 wires, some of these wires serving at the same time several offices of little importance. Of this number there are 96 for which direct communication has been established since 1878.

14 principal towns are still deprived of direct communication with Paris, but they will shortly be connected with it. We should add, that the greater part amongst them, although not possessing direct communication with Paris, are separated from that city only by one intermediate station.

The 50 extramural telegraph offices of la Seine and the 27 stations of Seine-et-Oise, which used to be connected with the office in the Stock Exchange by means of 36 wires, are at present connected with the central station, which allows of accelerating the transmission of a large number of telegrams by doing away with useless manipulations.

To the international and inland communications of the central station we further have to add 93 urban wires, which place it in communication with the offices in Paris.

(To be continued.)

THUNDERSTORMS.

DURING the fortnight ending on the 16th inst., very severe thunderstorms were experienced in various parts of Great Britain. Appended we give brief details of returns from numerous districts:—

About half-past four on Tuesday morning, the 12th inst., a thunderstorm broke over the metropolis. There had been flashes of lightning visible since midnight, and the atmosphere had become even more oppressive than during the earlier part of the night. Some of the peals of thunder were very heavy, and the lightning flashed vividly, but the centre of the storm did not appear to be over the metropolis, and after about half an hour it passed off. While the thunderstorm was at its height a flash of lightning was observed to descend over the house 64, Mile End Road, in the occupation of Mr. Paul, a public house broker. The lightning struck a high stack of chimneys in the front of the house, bringing them down with a tremendous crash into the street. Three men who were passing at the time on their way to work had a narrow escape. About the same time the lightning struck the telegraph wires which cross the Mile End Road, near Leslie Street, one of the wires being severed, and falling across the carriage way. Fortunately no one was injured, although a number of vehicles were passing at the time on their way to market.

At Waltham Abbey two horses were struck dead by lightning on Waltham Marsh. Two trees opposite the Royal Forest Hotel, at Chingford, Epping Forest, were also struck and completely shivered.

At Middlesborough a woman, while selling milk at North Ormesby, was struck by lightning, and rendered insensible. A farm labourer, named Michael M'Gurkin, 19 years of age, while engaged in sprinkling lime on a field at Old Ormesby was struck by lightning, and killed instantaneously.

In East Yorkshire large, irregular-shaped pieces of ice fell, causing great damage to the cereal crops and in orchards. The storm raged a couple of hours, and a deluging rain also fell. Intense heat followed.

A large barn of newly-mown hay was destroyed near Kendal, and the steeple of the old Hutton Church was almost demolished.

From noon till one o'clock on the 12th inst., Dundee and that district were almost completely shrouded in darkness. Thunder had been heard during all the forenoon, but as midday approached it appeared suddenly to cease, and the sky became densely overcast. At half-past twelve the darkness was as great as at midnight. The streets became immediately deserted, scarcely a human being moving about. Much consternation was caused by the extraordinary phenomenon. No attempt was made to light the gas, even in the public offices. At 12.40, when the darkness was greatest, the thunder began to peal and lightning to flash, and for the next half hour a storm prevailed such as has seldom been experienced

in this country. Rain fell in a continuous sheet, flooding the streets and causing great damage. The darkness cleared gradually away.

On Upper Deeside huge balls of fire were seen rolling down the slopes of Lochnagar, and the buildings at several farms were struck by lightning. Many persons had narrow escapes. The rain fell in torrents.

At Edinburgh, for about half an hour, the darkness was like that of midnight. Dwelling houses were flooded, and a house in Bristo Street was set on fire by lightning, which also struck the Clarendon Hotel in Princess Street.

At Glasgow the lightning was unusually vivid and frequent. One flash was observed to strike the steeple of St. Mark's Free Church, cutting away a part of the ornamental stone work and shattering the slates. Three large holes were made in the roof. Three men, while erecting a stack, were struck by lightning in Swanston Street and rendered insensible; one was so seriously injured that he had to be conveyed home. Sunnyside Railway Station was struck, and the chimneys and roof were shattered, but no one was injured. At Irvine the house of a ploughman was burned, and stacks of hay were destroyed in several places.

The lightning entered a house in the village of Whitletts, near Ayr, smashed the grate in one of the rooms, passed into the kitchen, and broke a large piece out of the hearthstone. A woman sitting by the hearthstone was uninjured. At Cambusdoon several sheep were killed under a tree, where a man had also taken shelter. In Maybole the chimney stack of a shoe factory was shattered, and the spire of the parish church was struck and greatly damaged.

A farm-house called Cefn Rallt, in the neighbourhood of Berriew, Montgomeryshire, was struck by lightning, and, with a stable and granary under the same roof, was set on fire and burned to the ground.

At Leith the roof of Bonnington's sugar refinery was struck by lightning, which also entered the police-station at Newhaven, ignited the gas, and destroyed the telegraph wire communicating with the head office at Leith. The lightning set fire to North Trinity House, and caused considerable damage. Grecian Cottage, Trinity, was also struck and the gas ignited. At noon the darkness was intense, and the rain and hail fell heavily.

A man named Taylor was killed by lightning at Little Langton, near Northallerton. A child in his arms escaped uninjured. Two houses were struck at Stockton and one completely wrecked. At Lewisham, near Whitby, hail-stones fell fully 1¼ inches in circumference.

Violent thunderstorms prevailed over the North of Ireland. In various parts of the County Down horses and cattle were killed. Reports from all parts of Ulster show that the storm was very general and the thunder and lightning extremely severe.

During a terrible thunderstorm in the Lauder district, on the 12th inst., which we noticed at greater length in our issue of the 16th inst., Lord Lauderdale was struck on the moors by lightning, and did not survive many hours.

The heavy rains pouring upon the hill-sides in Lancashire formed innumerable rills, which rushed into the bed of the Irwell, which rose several feet in 20 minutes. The storm raged with great fury over Newchurch, Waterfoot, and Cowpe, and for a quarter of an hour there was a rain of ice in fragments varying from three inches long to an inch in thickness. Rows of houses, schools, churches, and mills appear as if they had suffered from a riot, many windows having every square of glass broken.

At Staleybridge a farm-house and other buildings were damaged by lightning.

At Helston (Cornwall) a farmer was killed by lightning.

Near Burnley a man and a woman were killed.

At Ramsay, Isle of Man, a house was struck by lightning, the roof smashed in, and the furniture of two rooms destroyed. Another house was struck and a young man rendered temporarily insensible. An iron bedstead was twisted and the furniture and walls injured.

A young man named William Marsden, at Darwen, was struck by lightning whilst playing at football and instantly killed, and a young man named Richard Farnworth was also seriously injured.

At Ashton-under-Lyne, a chapel and farmhouse were struck by lightning. Several other buildings were also damaged.

The new parish church of Glendinnes, Banffshire, was struck by lightning and set on fire. The belfry was completely consumed, and the roof was much damaged before the flames could be extinguished. When its fastenings gave way the bell fell into the edifice, smashing many seats and some woodwork in the interior.

At Kirkcudbright, five calves and a foal were killed in a field during the storm.

In the North Isle of Man a farmer and his wife were seriously injured, and two horses were killed. St. John's Church steeple at Kirkmichael and the Mitre Hotel were struck, the contents of the drawing room and the lower room at the hotel being completely wrecked. In Ramsay the storm raged with appalling fury. Several sheep were killed in the fields.

At Bacton, Norfolk, a house was struck by lightning, which passed through the roof and on to the staircase, where the wife of Mr. G. Little, the tenant was passing. The poor woman was killed instantaneously. Her infant, abont twelve months old, which was in her arms, escaped, although the hair on one side of its head was burnt off. Two valuable horses at Congham were killed. At Ludham a double cottage was struck and burnt down. Several haystacks in various villages were also struck and burnt.

The supports of the railway-bridge at Farnworth, on the Whitby and Pickering branch of the North-Eastern railway, gave way.

At Gilmerton, near Edinburgh, the daughter of a ploughman was killed instantaneously.

At Ripley, near Woking, George Henry Mitchell, a painter, of Battersea, was killed by being struck by lightning whilst standing under a tree.

Two horses were killed near Dumfries.

A bull, three cows, and five calves, which were standing under a plane-tree, were killed instantaneously, and a cow a few yards off was temporarily paralysed in her hinder quarters. Some of the animals that were killed were as much as ten paces distant from one another, and two of them were exactly twenty-five paces from a shooting party. Although the atmosphere was stifling, lumps of ice as large as marbles fell during the storm.

Eight sheep were killed by lightning at Lockerbie.

At Meir, near Longton, North Staffordshire, a potter's printer, named Charles Brassington, was killed. Near Uttoxeter ten cows were killed by one flash of lightning while grazing in a field.

At Braidwood, a mineral brakesman named Smith, employed by the Caledonian Railway Company, was struck by the lightning and stunned. After a little he recovered somewhat, and was put into a carriage and taken home.

Near Stowe, a young man, named John Mackay, was struck by lightning and killed. A horse which he was driving was also killed.

At Fairlie, what is described as a fire ball fell and burst with an appalling crash.

At Thornton, a cow was killed. At Freuchie, the lightning entered a house, melted the gas pipes, and set the house on fire.

The lightning entered the house of an old man at Arnabog, and destroyed the mantelpiece, knocking a can out of the man's hand as he was sitting beside the fire.

East of Fife, stack of hay fired; telegraph instrument in Cellardyke post office ignited, setting fire to some papers which were near; derangement of the telegraphic apparatus on the railway; injury to a church steeple and a dwelling house; three cattle and one horse killed.

Two men were killed by lightning at Ballyward, seven miles from Castlewellan, County Down. Three valuable cows and a horse were killed at Waterask, between Newcastle and Dundrum, and a horse was killed near Castlewellan. Four cows were killed between Newcastle and Annalong.

It is calculated that in Scotland about 50 head of cattle, between 20 and 30 sheep, and 10 or 12 horses were killed. Five persons lost their lives, while many others were more or less seriously injured by the lightning.

From several places, what are described as "fire balls" were seen to fall.

An American contemporary relates the following story, which comes from Port Jervis, in the State of New York:—"Abraham Cuddeback until a few weeks ago was a highly successful and much-respected merchant of Damascus, Penn. About three months ago, while attending church in his native place, he was stricken with paralysis, and had to be carried to his home. Ever since that time he has been helpless, and many physicians from New York and Philadelphia have been called in and have striven to give him aid, but all to no avail. About three weeks ago, utterly broken down in health and despondent, he was removed to Matamoras, Penn., directly opposite this village. A physician has been in constant attendance upon Mr. Cuddeback since his removal to Matamoras. During the prevalence of a heavy thunderstorm that visited this section of the country on the 5th, a huge ball of lightning struck a house very close to the residence of Mr. Cuddeback, and, entering the house through an open window, hurled Mr. Cuddeback to the floor from a chair on which he was sitting. He was alone at the time, and after lying on the floor unconscious for some time, his wife came in and helped him to a chair. Restoratives were applied, and Mr. Cuddeback was soon himself again, and the happy discovery was made that he who a few minutes before was almost bereft of all feeling in his limbs, had entirely recovered the use of those members and was in apparent good health. Another peculiar phase of the case is that Mr. Cuddeback had no appetite a few weeks previous to this time, and after his strength and senses were restored he was taken suddenly hungry, and now has his accustomed appetite. The case is attracting considerable attention among the medical fraternity, and the many friends of the family in this vicinity are showering their congratulations on the happy pair for the recovery of Mr. Cuddeback's faculties and strength. The case is to be fully investigated by the physicians who have had charge of this most remarkable case."

Whitworth Scholarships.—The list of successful candidates in the last competition for the Whitworth Engineering Scholarships has just been issued. Six of these scholarships have been gained by Scotchmen:—Andrew C. Shaw, £150; J. Kerr Reid, £150; John Kemp, £100; William A. E. Crombie, £100; John Sharp, £100; and John Dongan, £100, all from Glasgow. The first two, the fourth, and fifth received their theoretical training at the College of Sciences and Arts, Glasgow, a technical college which has made great advances since its new constitution in 1881, and over which Principal Andrew Jamieson presides with such success.

NOTES.

Electric Lighting.—We are informed that negotiations have just been completed whereby the well-known dyers, Messrs. Pullar & Sons, Perth, have placed in the hands of Mr. D. Prentice Menzies, 106, Elliot Street, Glasgow, orders for an addition to their already large electric light plant, which consists of over 20 dynamos, compound and series. These are all to be re-arranged and a further addition made, consisting of 150 incandescents, each of 20 candle-power, and 14 arc lights of 4,000 candle-power. It speaks well for the electric light that (having already the largest plant in Scotland) the Messrs. Pullar should see fit to make this further addition.

Last week we notified that the Roman Catholic church of St. John, Old Cumnock, was about to be electrically lighted. On Sunday evening last the electric light was used for the first time with good effect. Mr. William Marsey, of Twyford, who carried out the electrical arrangements, is now engaged at Mount Stuart House, one of the residences of the Marquis of Bute, where it is proposed to use 400 incandescent lamps. Dumfries House will be similarly lighted.

The Government has decided to commence the system of lighting barracks by electric light by a trial at the Royal Engineers' barracks at Chatham, where favourable circumstances are found, during next year. The estimated cost is £5,000 for the installation, and £500 per annum for maintenance. The annual saving will be about £400. Should the trial prove successful, the system will be extended.

It having been decided to light the large and extensive works in Preston, known as the Park Lane Mills, with the electric light, the contract for the work has been given to Mr. F. D'A. Goold, electrical engineer and contractor, of Manchester.

The Chicago municipality, we learn from an exchange, has accepted the proposal of the Thomson-Houston Electric Company, of Boston, to furnish one six-light dynamo and six arc lights of the usual power to light the new Rush Street Bridge. The dynamo and arc lights are to be free to the city in consideration of the privilege of an advertisement of the company's name and address being placed "in a reasonably conspicuous place" on the bridge. The city is to furnish wires, engines, and boilers, and bear all other expenses except as above stated.

During the last week of July new corporations were reported as being formed throughout America, with a capital of $1,100,000, for electric lighting. There seems but little immediate prospect of a reaction in this direction in England.

We learn from the *Electrical Review* of New York that the Brush Electric Company has issued the following circular in reference to a matter mentioned in our columns last week:—"It will, no doubt, surprise our agencies and lighting companies to learn that a suit of this company against the U. S. Electric Lighting Company, which has been before the court for a long time past, has been decided by Judge Shipman in favour of the defendants. The decision was a great surprise to us, and we have every reason to believe it was fully as much a surprise to the defendants. There were a number of intricate points in the case over which great labour was spent by both sides, all of which were decided in our favour, and the case finally turned on a single point, which was a very simple one, and we supposed entirely clear. In 1876, two years prior to the date of Mr. Brush's patent, a man named Hayes made a lamp containing a clamp somewhat resembling the clamp used in the Brush lamp, but used quite differently. The lamp was a failure, and after a number of attempts to make it work properly, the clamp was taken off, thrown into a scrap box, and the whole matter dropped. No other lamp was ever made with the clamp, and as this one had never been regarded as successful, either by the maker or any one else, until it was thought that it could be made use of to beat us, and was, as we believed, purely experimental, we treated it as an abandoned experiment, and, therefore, no anticipation of Mr. Brush's invention, which was entirely successful from the start. Judge Shipman decided, but apparently after serious doubt, that it was not strictly an abandoned experiment, and on this point alone decided the case against us. The case will be at once appealed to the United States Supreme Court, and followed up to the end. The only issue involved in the final hearing of this suit was the lifting and feeding clamp in the lamp. We have other suits still pending against the agents of the United States Company, or users of its apparatus, on other patents that are of much more importance than the one recently decided. We also have a number of other suits on various patents against other systems of lighting, as will be seen by the accompanying list, and infringers will do well to bear in mind that so far only a single one out of more than 40 Brush patents has been judicially declared invalid, and we propose, as heretofore, to prosecute all infringers who disregard our rights. Suits are now in progress in various United States Circuit Courts against users of infringing apparatus covered by patents other than the one passed on by Judge Shipman. Among these are suits against users of the following systems:—The United States (Weston), The Fuller Electrical Company, The Excelsior Electric Light Company (Arnoux & Hochhaussen), The Schuyler Company, The Van Depoele Company, The Boulton Carbon Company, The Pittsburgh Carbon Company. Suits are also in preparation against other infringers, including the Thomson-Houston System, which infringes some of our most important patents upon the dynamo machine. The above suits include many different patents, all of which are controlled by us.—The Brush Electric Company, Cleveland, Ohio, July 22nd, 1884."

Telephonic.—"B," writing from the Dublin Stock Exchange, recommends the establishment of trunk lines of telephones connecting the principal provincial cities with London.

The Post Office and Telephones.—A special meeting of the Glasgow Chamber of Commerce was held on Monday in the directors' room of the Merchants' House for the purpose of hearing a statement and suggestions by Mr. W. A. Smith in reference to the telephone companies and the Post Office. Mr. John M'Laren presided. The secretary read the minutes of the meeting of the Home Committee, which recommended that the directors should agree to the following resolutions:—"The directors of the Chamber, while viewing with satisfaction the liberal nature of Mr. Fawcett's proposals in regard to the use of the telephone in this country, after experience of which it is earnestly hoped may in future enable further facilities to be conceded without loss of revenue to the Post Office department, respectfully submit for Mr. Fawcett's consideration—first, that the charging of a royalty of 10 per cent. on the rentals of private lines should not be insisted on, in respect that it places an undue burden upon the telephone; second, that the running of wires between the Post Office telegraph stations and telephone exchanges for the purpose of receiving and despatching telegrams to and from subscribers to such exchanges should be sanctioned and encouraged, and that in all cases where telephone companies are prepared to bear the cost of such wires and guarantee to the department due payment on telegrams so transmitted, no burden should be imposed on this facility to the development of the Post Office revenue."—Mr. Smith said the two points to which he desired to call attention was that the telephonic exchanges should be connected with the central telegraph system of the Post Office. Mr. Fawcett, in all the arguments he had urged against the proposal, had said that he must protect the public revenue, that he was trustee on behalf of the Post Office, and that having bought the telegraphs he must make them pay, no matter how private industry might languish. But

this particular demand was one that could do nothing but bring the Post Office net revenue. Another reason why he asked the Chamber to move in the matter was that about three years ago he submitted to St. Martin's-le-Grand an offer to make the experiment in Glasgow, and in that offer he came under an obligation to pay all the expense of running the wires to George Square, to pay the rental of a room, to pay the cost of the operators necessary to take in the messages, and to guarantee to the department by depositing £500, £1,000, or whatever sum might be required. Furthermore, he undertook to free them from all liability as to the correct transmission of telegrams so sent through the telephone. The answer he got was that any firm which desired this facility should pay five guineas per annum—the price of 105 messages—and that thereafter they would be allowed to pay for telegrams like any ordinary individual. Of course, they would see that when the expense was to be on the company, and the revenue was to go to the Government, the company did not see their way to ask subscribers to pay an additional five guineas per annum. It was useless for Mr. Fawcett or the permanent heads of departments to say that this facility could not be granted. Newcastle had now just what the St. Martin's-le-Grand officials refused to concede to Glasgow three or four years ago. In the Newcastle Exchange there were five or six boxes in which operators sat for no other purpose than taking in telegrams from subscribers to the telephone system. He thought it must be quite clear to all that he had no desire to speak on behalf of the telephone companies. There was no proposal that the companies should receive any portion of the price of these telegrams, although in America they did allow the telephone companies 20 per cent. on the receipts from said companies. The companies were willing to go to the expense of providing their subscribers with additional facilities, hoping to reap an indirect benefit. By what had been called a mere accident of the drafting of an Act of Parliament, the Postmaster-General was enabled to substantiate his claim to impose a royalty on telephonic exchanges, but by no act under the sun could he demand payment of an additional royalty. There was nothing at present enacted to prevent anyone running private telephone wires and ignoring the Postmaster-General altogether. That argument, he thought, spoke for itself. He had only further to ask them to remember that when the telephone was first submitted to the Postmaster-General, the scientific heads of the department said it was a mere toy, and of no use at all. The invention was then taken up by others, and since its adoption every obstacle had been thrown in the way of its development by the Post Office, not by Mr. Fawcett, but by those under him. Mr. Fawcett had swept away with a liberal hand many of the absurd restrictions placed upon it. But while he had been giving with the right hand he had been taking away with the left, and the additional royalty would amount to fully 25 per cent, more than had hitherto been exacted from the telephone companies. He thought, in the interest of the public, action should be taken at once to get him to forego this additional royalty, which would be just a tax on the public. The telephone companies were not philanthropic companies, they wanted to make money if they could, and the royalty, if imposed, would affect the charges. In conclusion, he repeated that the whole trouble which threatened them was simply the outcome of the fear that the heads of certain departments in the Post Office had of the development of the telephone. After a discussion, it was resolved to memorialise the Postmaster-General in the terms recommended by the committee.

The Telephone and Fire.—At a fire which broke out on the premises of Messrs. Platnauer, Victoria Street, Bristol, last week, and which proved to be of a very destructive nature, the telephone was called into service, and was found to be of great value in rapidly calling the attention of the fire brigade to the outbreak.

The River Plate Telephone and Electric Light Company, Limited.—It having been suggested by the committee of investigation of the Consolidated Telephone Construction and Maintenance Company, that the shareholders should individually purchase from their company shares held by it in the River Plate Telephone and Electric Light Company, the New York *Electrical Review* thinks it may be well to acquaint them with certain facts relative to telephone interests in the River Plate, in regard to which it is probable the gentlemen recommending them to make the investment referred to are themselves not thoroughly informed, but which have an important bearing upon the value of the suggested investment. The properties of the River Plate Telephone and Electric Light Company are situate in the cities of Buenos Ayres and Monte Video. In each of these cities there exists an opposition company, with more subscribers than the River Plate Telephone and Electric Light Company. The instrument in use by these opposition companies —the United Telephone Company of the River Plate in Buenos Ayres, and the Campania Telefonica La Uruguay in Monte Video—(and for which these companies possess exclusive rights) is that known as the "Bell-Blake," the only one used to any extent by telephone exchanges in England and the United States, and generally throughout the world. The instrument used by the River Plate Telephone and Electric Light Company, and the only one which that company has the privilege of using, is known as the "Gower-Bell," and is universally acknowledged to be an inferior and almost obsolete instrument. In the city of Buenos Ayres, the River Plate Telephone and Electric Light Company had, about one year ago, more than double the number of subscribers of the opposition company there. It now has less subscribers than that company. On February 1st of the present year there was no opposition to the River Plate Telephone and Electric Light Company in Monte Video. The opposing company in that city has already a larger number of subscribers than the River Plate Telephone and Electric Light Company. The rapid growth of these opposition companies is chiefly due to the superiority of the instruments used. It is but reasonable to anticipate that this superiority will continue to make itself manifest. The United Telephone Company of the River Plate represents the interests of the most powerful telephone organisations of the United States, where the telephone has been made a far greater scientific and financial success than in any other part of the world. It is also allied to various local companies in the River Plate, having exchanges in Rosario, Santa Fe, Cordoba, and Parana, as well as at Monte Video. It can hardly be supposed that the gentlemen constituting the committee who recommend the purchase of these River Plate Company's shares, in the brief period they have been able to devote to their investigations, have become fully conversant with the situation of telephone affairs generally in the River Plate. A more extended and thorough investigation than they have yet had time to make would not, it is believed, have afforded proper grounds for such a recommendation.

Cable Intelligence.—The Great Northern Telegraph Company notified at the beginning of the week that telegraphic communication with Amoy was interrupted; but the connection has since been restored.

The Great Northern Telegraph Company further announces that the courier service from the landing-point of the Shanghai-Foochow cable up to the latter town having been stopped by the Chinese authorities, telegrams for Foochow, as sent hitherto, will only be accepted at sender's risk. Telegrams for Foochow may, however, be forwarded *viâ* Shanghai by means of the Chinese landlines. The rate for telegrams forwarded in this manner, which should be marked "*viâ* Chinese Landlines" (these words are not charged for) is 10s. per word. The company's system in China has now been extended to Pekin.

The Eastern Telegraph Company also announces the

opening of a station at Pekin, the rate to which will be 10s. per word.

The Bennett-Mackay Cable.—The *Faraday* finished paying out the deep-sea portion of the second Bennett-Mackay cable on board on Tuesday morning, and returned immediately to Woolwich to receive the remaining deep-sea portion and the American shore-end.

Telegraph Extension.—A correspondent writing from Swatow, says:—"During the summer a gentleman connected with the Great Northern Telegraph Company made a survey for the route to be taken by a telegraph line to connect Canton, Swatow, Amoy, and Foochow. Many of the poles and other material are being collected, and it is rumoured that the line will be soon commenced."

Telegraph Revenue.—The receipts on the telegraph service from April 1st to August 23rd, 1884, were £755,000 against £750,000 from April 1st to August 25th, 1883.

Electrical Gas Igniters.—In our article on Clarke's apparatus, published in last week's issue of the REVIEW, we remarked that we were under the impression that this gas-igniter was the first in which static electricity has been applied in a really useful and practical manner. Messrs. Woodhouse and Rawson have, however, brought to our notice an apparatus prior to that patented by Clarke, in which it is claimed that the same principle is employed, and which they have recently acquired and taken up the manufacture of. The instrument in question was first patented by Mr. A. R. Molison, and is dated March 12th, 1883. An improvement on this was patented on the 23rd of October of the same year, in the joint names of O. E. Woodhouse, F. L. Rawson, and A. R. Molison. Clarke's specification is dated 31st December, 1883. It will be seen, therefore, that Mr. Clarke has been forestalled in the application of static electricity for the purpose of gas lighting. We understand that instructions have been given by Messrs. Woodhouse and Rawson to their solicitor to apply for an interim injunction against the Electric Portable Battery and Gas Igniting Company, Limited, of Manchester, who are the proprietors of Clarke's patent. We may mention that Molison's apparatus is a self-inductive "plate" machine of the Voss or Varley type, although in the specification dated 23rd October, mention is made that the cylindrical form of machine may be used.

The Electrical Transmission of Power.—We read in the *Journal du Gaz et de L'Electricité*, that a new application of the electrical transmission of energy was installed a few months ago in a coal mine in the neighbourhood of Vienna, Austria, and works regularly, and with great success. Both the machines are Gramme dynamos; the generator furnishing a current of 15 ampères at 500 volts. The receiver, says our contemporary, produces about 8 H.P. at a distance of 1,900 metres, and actuates a pump which delivers 300 litres of water per minute at a height of 60 metres, and through a conduit 800 metres long. This was formerly worked by a steam engine, which rendered the temperature of the gallery uncomfortably high. The employment of the dynamos has caused a lowering of temperature of 14°; it appears, also, that the consumption of fuel is considerably reduced. We fancy that the return claimed for the receiver would bear a considerable amount of reduction.

The United States Electrical Commission. — In accordance with the provisions of an act of Congress passed at the last session, the United States Electrical Commission, to sit during the electrical exhibition at Philadelphia, has been officially constituted. The following-named gentlemen have been designated as members of the commission:—Prof. H. A. Rowland, Prof. M. B. Snyder, Prof. J. Willard Gibbs, Prof. John Trowbridge, Prof. C. A. Young, Prof. G. F. Brackett, Dr. William H. Wahl, Prof. Simon Newcomb, Prof. G. F. Barker, Prof. E. J. Houston, Prof. R. A. Fisk, Prof. Francis C. Van Dyck. It is not definitely known what subjects will be discussed, but the following topics have been suggested:—The sources of electrical energy; the theoretical conditions necessary to the most efficient construction of the dynamo-electric machine for the various purposes of practical work; the electrical transmission of energy; the systems of arc and incandescent lighting; the theory of the electric arc, storage batteries, electro-metallurgy; light-houses for the coast; applications of electricity to military and mining engineering; lightning protection; induction in telephone lines, and the problem of long distance telephoning; the question of underground wires; atmospheric electricity; earth currents and terrestrial magnetism; photometry and standards for photometric measurements; the ratio of the electro-magnetic to the electro-static system of units and the electro-magnetic theory of light; and, finally, on account of the pressing necessity for accurate and uniform electrical measurements, it is probable that the question of establishing a National Bureau of Physical Standards will receive proper attention.

The Cleveland Electric Street Cars.—The Cleveland *Herald* says that the machinery for a second electric street car is in place, and the car will be running in a few days, when the interesting experiment of passing two cars—one on a switch and the other on the main track—will be tried. The mechanism to enable this to be done is said to be very simple. It is an automatic arrangement that reverses the current, much as the electric currents are switched about on the keyboard in a telegraph office. Mr. Knight has no fear but the two cars will run as well as a single one now does. It is difficult to understand how the car now running on the Garden Street extension could be improved. It ran up and down the line at a speed often exceeding the fastest time of a street car team. A test of the power of the motor was made the other day, when a second coach was attached to the electric car, and 100 passengers were drawn with ease. One change in the mechanism of the car will be made. The full electric current is coursing through the machine even when the car remains stationary, and if it stands any length of time the motor becomes highly heated. When the car is running, the motor is not heated to any great extent. The new device will enable the operator to turn off the current, and thus relieve the motor when the car stops. An unexpected drawback is the fact that half the horses that pass the car are frightened by it. There is nothing unusual in the appearance of the car, and it makes no noise besides the whirr of the motor, running at about 1,000 revolutions a minute. The whirr cannot be heard outside the car, but the sight of the vehicle moving off with apparently nothing to propel it is a source of constant surprise to a horse. Even old plugs were frightened, and one passenger opined that the horses, jealous of a loss of business, had combined to express their disapproval of the invention. As showing the financial success of the invention, Mr. Knight said:—"The aggregate expense of running two cars will be $5 a day. From eight to twelve horses to a car are required on a street car line. Two electric cars will displace 25 horses on this road, and the daily expense of the animals is about $13. The life of a street car horse is about three years, while a motor will last 50 years. In fact, there is little about it to wear out—so little that none of the electric light machines, which have been put up by the Brush Company, have ever required repairs, and the question of wear is hardly taken into account."

The British Association Meeting.—We may mention that amongst the English visitors arriving in Montreal on Monday afternoon, was Mr. H. Alabaster, of the ELECTRICAL REVIEW.

Obituary.—The death is announced, we see in a financial contemporary, of Mrs. Thomas A. Edison.

New Torpedo Boats.—The new torpedo boat of Captain John Ericsson, according to a contemporary, will be one of the most terrible of all engines of warfare. This boat, now nearly completed, will be able to overtake the swiftest vessel afloat, can elude all missiles that may be hurled at it, and will carry a torpedo which can shatter and sink the strongest ship. The torpedo differs from all others, and the firing will be either by electricity or compressed air.

Professor Tuck's electric submarine torpedo boat looks at a little distance very much as if it had been constructed by laying a large row boat, upside down, on top of another large row boat, fastening it there, and painting them both sea green. The shell is of iron, however. The boat is thirty feet long. It is ballasted with lead, so as to sink to the water's edge, and its displacement is 20 tons. In the centre of what may be called the deck is sunk a well hole. By a simple air lock arrangement it affords a passage between the interior and the exterior of the vessel, even when the vessel is wholly under water. The boat has three rudders, one an ordinary vertical rudder at the stern, and the other two horizontal blades on the port and starboard quarters. These last help to govern the boat's movements up and down. To sink her, water is pumped into her compartments; to raise her, air is pumped in, and the water is forced out. Compressed air is stored aboard in six-inch pipes. There is also an apparatus for reoxygenating air that has already been breathed. Moreover, there is a simple arrangement by which the ends of two rubber tubes can be floated up to the surface of the water and there opened to the supply of fresh air. An electric motor, driven by storage batteries, runs the propeller. The interior, which is arranged for a crew of four or five men, is lighted by incandescent lamps. An indicator shows the distance of the boat beneath the surface. The estimated speed of the boat under water is eight knots. The torpedoes are to be carried outside the vessel, one at the prow and one at the stern. They are to be held there in iron cylindrical sheaths by electro magnets, which will release them when the current is cut off. They are ballasted with cork, and after placing one of them the torpedo boat retires to a distance, unreeling as it goes two wires, by which, at a proper distance, the torpedo is fired. The lead ballast proved insufficient to sink the boat below the water. On a recent trial near the Delamater iron works, New York, a crew of three men went aboard her, and, with Mr. John Rice as captain, a test was made of the electric motor. It drove the boat several miles up and down the river at a speed of ten knots, says the New York *Sun*. She answered her rudder well. She will soon be tried under water.

A New Thermo-Electric Generator.—The New York *Electrical World* states that L. G. Woolley, of Indianapolis, one of the inventors of the locomotive electric headlight, has invented a thermo-electric generator, which is believed by experts to be the beginning of a revolution in the use of electricity. The generator is like a copper boiler, and stands on the frame of an ordinary sewing machine. It is operated by a coal oil lamp, and the flame of one used at night to give partial light in a sick room furnished a supply of electricity which ran a one-horse engine and illuminated four incandescent lamps. The inventor claims that he will be able to furnish motive power for all purposes in which stationary engines are used at one-twentieth of the present cost. His generator is attached to a telegraph wire running from Fleuago to Louisville, and thence by a loop to New Albany, and with the expenditure of no material except the oil in the lamps under the generator, is supplying all the electricity needed for telegraph purposes. We (the ELECTRICAL REVIEW) are inclined to look upon the whole concern as a very "one-horse" affair.

An Electric Lighthouse in Brazil.—An electric lighthouse has recently been erected on the Island of Raza, at the entrance of the Bay of Rio Janeiro. The lighthouse proper is 85 feet high, and is put upon a rock 230 feet in height, so that the focus of the light of the apparatus is fixed at an elevation of 315 feet above the sea. The electric fluid is produced by a continuous-current Gramme machine, working at the rate of 700 revolutions and feeding a light of 2,000 C.P. The Gramme machine referred to is actuated by a stationary surface condensing steam engine; this arrangement being inevitable owing to the want of fresh water. All the fittings are double, so as to prevent interruptions by unforeseen accidents; and, to make assurance doubly sure, an oil lamp is always kept in readiness. The light is revolving; having two white discs and one red one, succeeding one another at 15 minutes' interval, and the light is visible at a distance of about 35 statute miles.—*New York Electrician and Electrical Engineer.*

A Telephonic Cab Service.—The New York Cab Company, states the *Electrical World* of that city, began on the 7th inst. a special service of their cheap cabs at the Grand Central Station. A stand has been erected at the southerly end of the station, inside of the gate, and an agent of the company will receive all passengers on the arrival of the trains. Heretofore travellers have been unable to reach the cheap cabs, or in fact any other conveyances, except at great inconvenience, being forced to run the gauntlet of a small army of boisterous hackmen. Hereafter the cheap cabs may be ordered by telephone from the Forty-second Street station. No extra charges are made by the company for their new accommodation to the public, although considerable expense has been incurred.

The Bartholdi Statue of Liberty.—The corner-stone of the Bartholdi Statue of "Liberty Enlightening the World," given by France to the United States, was laid at Bedloe's Island, in New York Harbour, on August 4th. The pedestal proper will be 114 feet high, and will stand on a high terrace of the island. The height of the statue from its base up to the top of the torch is 151 feet. In the course of his oration Mr. William Allan Butler said: "It is proposed, as I understand, that the torch to be uplifted in the hand of the Statue of Liberty shall receive its illuminating power from an electric light. This wonderful gift of science to mankind is the crowning result of the electrical researches and experiments which Franklin initiated by the bold and simple and successful methods which placed him in the front rank of experimental philosophers, and secured for him the congratulations of the French King. Franklin believed in the sincerity of the French people, he attested the vast and inestimable worth of their aid, and declared over his own honest hand that they 'expected no return but that of gratitude and friendship, and these,' he adds, 'I hope may be everlasting.' These words, which he wrote to Robert R. Livingston more than a century ago, are the groundwork of the thoughts I have briefly and imperfectly expressed to-day. The hand that wrote them is in the dust, but the sentiments they embody and the wish they breathe are imperishable and will be perpetuated in the enduring monument for which this solid resting-place is preparing. And when, from the beacon which crowns it, shall shine forth the electric light, the consummate fruit of labours in which Franklin was the pioneer, wrought out to perfection by patient toilers who followed in the path in which he led, it will be indeed a fit emblem of the torch of Freedom, kindled by a celestial spark, guarded and kept alive by heroic service, and at last lifted up to the safe and serene height—a light to lighten the world."

Personal.—Mr. John Pender, M.P., has been presented with the freedom of the Royal burgh of Wick in recognition of his public services. Mr. Pender has represented the Wick burgh for 12 years.

Edison's Megaphone. — The steamer *Tallapoosa*, writes a Washington correspondent to the New York *Electrical World*, has aboard it, for experimental purposes, one of Edison's most recent inventions, called a megaphone, which is nothing more nor less than a machine for magnifying sound, a sort of telescope for the ear. The effect and purpose of it are to enable a person to hear or carry on a conversation with people at a distance. The purpose of the invention is to aid mariners in listening for the sound of breakers, or carrying on conversation with people on shore or on other vessels at a distance.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cordner Allen and Company, Limited.—(Electrical Engineers.) The registered office of this company is at 20, Bucklersbury, E.C.

Ferranti, Thompson and Ince, Limited.—The announcement of the final winding up meeting of this company, held on the 25th June, was duly registered on the 7th ult. At the meeting a statement was made showing the manner in which the winding up has been conducted and the property of the company disposed of.

Davis and Timmins, Limited.—Under an agreement, dated 6th inst., and registered on the 12th inst., the company will purchase the goodwill of Mr. Emile Davis together with the machinery, plant, stock-in-trade, patterns, fixture fittings and effects in connection with the premises known as Enterprise Buildings, Bowling Green Lane, belonging to such business. The purchase is made upon the footing of the stock account and balance-sheet dated 31st December, 1883. The purchase consideration is £6,000, payable £4,000 in cash and £2,000 in fully paid shares.

Etéve Engine Company, Limited.—Under an agreement, dated 22nd inst. and registered on the 23rd inst., entered into with Mr. Albert August Moll, of 77, King William Street, this company will purchase certain American Letters Patent granted to Eugene Etéve and others, for gas engines. The purchase consideration is 3,000 fully paid shares of £50 each. The registered office of the company is at 15, New Broad Street, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Pilsen-Joel and General Electric Light Company, Limited.

THE third ordinary general meeting of this company was held at the Cannon Street Hotel, on Thursday, under the presidency of Sir Rawson W. Rawson, K.C.M.G., C.B.; the attendance of shareholders was very small. The directors' report appeared in our last issue.

The Secretary, Mr. Gregory, having read the notice convening the meeting,

The Chairman said: In moving the adoption of the report, I think I shall consult your convenience by not detaining you with any lengthened remarks. The board have carried out the intention which they expressed at the last general meeting, to carry on the business to the best of their ability in the expectation that during the winter they would be able to place the business of the company on a sound and profitable basis, or, failing that, they would come to the shareholders, lay their case before them, and leave them to decide whether the board should continue to carry on the business, or adopt measures for limiting the expenditure, and to avoid further loss of money. The board deplore with you the result of last year's working. It has not been from any negligence or inattention on their part; they have done their best in the interests of the company; they have devoted their time and their best services to the shareholders without any reference to personal considerations, at a very great expenditure of time, and, I can assure you, with much anxiety. We have done our best; but there are impediments to success in electrical working with which you are all familiar, and which have led to the fall of so many other companies. We have evidence of the difficulty of companies carrying on works for electric lighting with a prospect of success at the present time. We anticipated when we met last year that the public during the winter would set its mind again on the electric light; but, as we have stated in the report, the difficulties created by the Act of Parliament, the existing state of trade, the indisposition of persons to involve themselves in new and uncertain expenditure, have all combined to hinder persons from having installations. At the present time there is a better prospect; but not such a prospect as would induce us to embark in any new installations with a risk of involving shareholders in further expenditure, and rendering it necessary to call upon them for further contributions. The directors are, we believe, in entire harmony with the shareholders. It is not expedient to take any action that will incur the risk of a further call. The last call was made for the purpose of carrying out a special object—a most important object—agreed to by the shareholders, unanimously, in the month of March, namely, to reduce our liability towards the fully-paid shareholders; we have succeeded in completing that arrangement and the shareholders are entirely free from any obligation beyond the balance of the debts which they owed on the 30th June, and the credits which they possessed on the 30th June. The total indebtedness is £4,000, the credits £3,000; consequently the company is liable at the present time upon its assets to the extent of about £1,000. Under these circumstances, we see that we can save the shareholders from any risk of further calls, if they combine with the directors in the action which we have proposed. We have laid before the shareholders, with perfect frankness and honesty, the exact position of the company. We have also, after the best consideration we could give, suggested the policy which we believe our shareholders are prepared to adopt. We hope they will act with us in this matter by adopting that policy as set forth in the report. I may say for myself that at our meeting in March I said I saw a rift in the cloud, that I believed at that time there was a chance of our being able to carry on a business at a profit before the winter. I must confess my thorough disappointment in that respect. I do not see at the present moment, with the capital we have already expended, the chance of our doing business likely to yield dividends to our shareholders. Therefore we think it better to avoid all future expenditure until there be some opening, and if there be no opening we shall come and tell you so. I myself, and, I believe, most of my co-directors are firmly of opinion that there is a future for electric lighting, and that that future is hastening on; we believe that the work of the last two years by our company, and by other companies, has cleared away many difficulties in the way of electric light installations; we believe that electric lighting may be carried on, not only successfully, but profitably, but it will require a great deal of management and a great deal of economy, a much cheaper factory than we have had from the beginning and a much more suitable organisation than that under which we exist, to secure a profit. For these reasons we have suggested that we should stop all expenditure, that we should have a limited number of directors, and try to engage other competent persons to complete what business we are under obligation to carry out, that is, our contracts, so that we should not require to keep up the expense of a factory, the engines and the staff there. We believe that by adopting that course, and awaiting the development of electric lighting, we shall be able to save a considerable sum for our shareholders. Upon these grounds we act with considerable confidence, having communicated with many of the principal shareholders and received their approval of the course proposed. There is an omission in the report: it was not stated that General Hopkinson, one of our original shareholders, resigned after our first meeting, and that we did not consider it expedient to fill up his place. The report mentions that Mr. Fellows, one of our directors, had not adopted the same view as ourselves with regard to resigning. Mr. Fellows has devoted a great deal of attention to the affairs of the company, and has been regular in attendance both on the board and at the factory. He has looked into the business of the company with great diligence and great interest. He does not agree with us as to the policy of our placing our office at your immediate disposal, nor does he believe that he is bound to do so under the circumstances. We believe that it was intended by the alteration of the 81st article of association that we should retire at this meeting; but Mr. Fellows is of opinion that we are not called upon to retire until 1886, although his colleagues think it their duty to resign now for the purpose of enabling you to make such an appointment for the future direction as may ensure your confidence. With these remarks I beg to move that the report and the general accounts for the past year be adopted.

Mr. Scriven seconded.

Mr. Joel said, with reference to the statement in the report, that "no company has fared better in this country than ourselves," that the Anglo-American Brush Corporation, by careful management, had succeeded much better than this company. They (the Pilsen Company) had had practically the best lamp in the market, a first-class organisation, and they started with greater advantages than any other company; they had perfect confidence in their directors, there was no Stock Exchange speculation to stop them, so that they ought to have done better. He had written to various companies and others with the view of getting some data as to the electric light-

ng being carried on in this country. He had ascertained that very little work had been done by the companies, but private firms had done a great deal, and had done it well and properly. The tables with which he had been furnished showed a record of a very great amount of electric lighting in this country; so it was evident that there was work to be done, and their company had not done it. He attributed the losses of £6,000 for the year before the last meeting, and of £11,000 for the year just past to the fact that the directors had ignored technical assistance; they had tried to manage a technical business without proper advice and had failed, whilst others had good assistance at their backs, and had done better. He thought it a great hardship that he had to leave the company after twenty months, but there was no help for it, he had to go. He had a great interest in the company, and he wished to look after his investments. He believed a great deal of the money had gone in experiments to instruct the directors and the factory committee in the very elements of electrical work, whereas if they had had proper advice this would not have been necessary. No mention was made in the report of the Colonial patents; but surely they were of some value. The directors said there was a chance of carrying on business by the payment of royalties; six months ago he brought an offer from people who were willing to manufacture their lamps and pay a royalty upon them, and if that had been accepted he had no doubt he could have got twenty other firms to do the same. They would probably have got £2 per lamp, and then their patents would have been worth something immediately. He had received 33 letters from persons who had used the Pilsen lamp in Germany, and all were splendid testimonials, so that they had patents which were of real value. Mr. Joel handed to the chairman twelve questions relating to the results of installations and to the management generally.

Mr. Quilter spoke approvingly of the proposal of the board. He did not agree with one remark made by Mr. Joel, who said this company had suffered from a want of technical assistance. He (the speaker) was acquainted with many companies that suffered greatly from too much technical assistance.

The Chairman said, with regard to Mr. Joel's questions, that that was scarcely the time or the place to answer them, nor did he think the shareholders could be judges between Mr. Joel and the directors. They had not found what was called technical knowledge of so much use to them that they were able to dispense with practical and economical considerations.

Mr. Joel pressed for answers to his questions, remarking that he had a large interest at stake and wanted to know what was done with his money.

The Chairman said surely Mr. Joel did not expect him to answer a series of twelve questions each one of which would require ten minutes' explanation, and of which he had given no notice.

Mr. Quilter said he should object to some of the questions being answered publicly.

The Chairman said Mr. Joel some time ago offered to make 100 Pilsen lamps at £2 per lamp royalty, but they knew that the object was to employ those lamps with dynamos of other manufacture and so far help to take the bread out of their mouths; they were also not satisfied with the terms of the offer, and they did not accept it. But as to manufacturing generally on a royalty, they were quite willing to do so.

The adoption of the report was then unanimously agreed to.

Mr. Edward Ellis moved that the number of directors be reduced to four, or, if Mr. Fellows continued to act, to five.

Mr. Rawson seconded the motion, which was carried.

Mr. Ellis then moved that the board be composed of Sir Rawson W. Rawson and Mr. Scriven of the present board, and Messrs. Alfred Parrish and Whatley. The two last named gentlemen were members of the committee which assisted the board in the recent transactions to which reference was made in the report, and had proved themselves able and experienced men.

A Shareholder, upon enquiry, elicited the fact that Mr. Whatley was a solicitor, and was paid for his services on the committee.

Mr. Quilter moved an amendment that three directors should be appointed, a vacancy to be left to be filled in by the board, subject to the approval of the shareholders.

Mr. A. Raymond Barker seconded this, and, after some discussion, it was carried.

Sir Rawson W. Rawson, Mr. Scriven, and Mr. Alfred Parrish, were then elected, and article 86, fixing the remuneration of the directors at £1,500 a year, was rescinded.

A motion having been carried calling upon Mr. Fellows to resign his seat at the board, the meeting was adjourned until the 12th September, when the remuneration of the board and the election of auditors will be considered.

The Union Electric Light and Power Company, Limited.—At an extraordinary general meeting of this company, held at St. Stephen's Chambers, Telegraph Street, on the 22nd inst., the following special resolutions were confirmed:—"That the Union Electric Light and Power Company be wound up voluntarily; and that the present directors, Mr. Dillwyn Parrish, Mr. Alfred Parrish, Mr. John Goddard, jr., and Mr. James Fyfe, be, and they are hereby appointed liquidators."

French Electrical Power Storage Company, Limited.—The Vacation Judge has fixed September 3rd for the appointment of an official liquidator.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 18th, were £2,316, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited. Receipts for the week ending 22nd inst. were £2,609, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1884.

11453. "Magneto-electric and dynamo-electric machines." R. E. B. CROMPTON, G. KAPP. Dated August 20.

11501. "Electric arc lamps." C. LEVER. Dated May 30. (*Complete.*)

11521. "Electric batteries." J. H. JOHNSON. (Communicated by P. G. Skrivanow.) Dated August 21.

11542. "Dynamo-electric machines." S. WILLIAMS. Dated August 22.

11602. "Thermo electric batteries." G. ZANNI. Dated August 25.

11617. "Short circuiting incandescence lamps arranged in series." C. D. ABEL. (Communicated by Siemens and Halske.) (*Complete.*)

11635. "Dynamo-electric machines." T. PARKER. Dated August 26.

11644. "Operating railway signals and apparatus from a distance." J. COLEMAN, J. HENSON. Dated August 26.

11653. "Electric batteries." C. D. Abel. (Communicated by E. J. N. Onimus.) Dated August 26.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

5807. "Telegraph transmitters and electric circuit controllers." E. A. BRYDGES. (Communicated by W. F. C. M. McCarty, of America.) Dated December 19. 6d. Relates to apparatus for controlling simultaneously and automatically by a single apparatus a number of electric circuits, entirely independent of each other and connected to different sources of current, or a number of circuits which are derived from a single source of current or to control by a series or number of contacts a single circuit.

5856. "Electric batteries." W. P. THOMPSON. (A communication from abroad by I. C. Himmer (wife of V. Himmer), of America). Dated December 24. 6d. The invention consists in supporting an annular series of carbon rods within a suitable jar or cell, and in securing an electrical connection between the several rods thus supported by means of one or more connecting plates of the same material. One of the carbon rods is provided with a metallic or conducting cup or thimble which fits over the top of the same and is secured thereto by means of suitable metallic pins. The zinc electrode extends between the rods and through the annular connecting plates, and carries at its lower extremity a suitable cup or thimble for containing a quantity of mercury. This cup may be provided with a lid of cork or other suitable material which will not be acted upon by the exciting agent of the battery, and by means of this cover the cup may be attached to the zinc. Suitable apertures are formed through this cover for permitting the mercury to escape from the cup and amalgamate with the surface of the zinc electrode. The cup may, however, be open and held in the proper position at the lower end of the zinc by being fitted tightly between the lower ends of the carbon rods.

5885. "Indicating or signalling time by electricity." A. G. BROOKES. (Communicated from abroad by L. N. Downs, of America). Dated December 28. 8d. The object of the invention is to provide a method and apparatus by which the subscribers of a telephone system may be provided with the correct time from a single standard clock by signals repeated in continuous succession throughout all the minutes of the day, and without the necessity of electric clocks, or dials, or, in fact, any complex or additional apparatus whatsoever, thus avoiding any necessity for the indefinite multiplication of electric clocks and the contingent expense and complication of operation.

5926. "Dynamo-electric machines and electric meters." S. Z. DE FERRANTI. Dated December 29. 1s. 6d. The object of this invention is first to construct a dynamo-electric machine by which a continuous current may be produced without the use of a commutator. For this purpose the inventor employs a metallic disc of a good conducting non-magnetic metal, such as

copper, revolved between two fixed annular poles of an electro magnet. The pole on one side of the disc being a North pole and on the opposite a South pole. He connects the outermost ends of the magnet poles so as to form a horse shoe magnet by projections from them, which are made to meet together outside the outer circumference of the revolving disc. Each annular pole piece of the magnet he surrounds by insulated conducting coils, through which the magnetising current is passed. When the disc is revolved, an electric current is induced in it radially to or from its periphery and axis. To carry off the current from the periphery, the inventor makes contact between the outer edge of the disc and a fixed metallic casing passing around it by means of a film of mercury interposed between them, and carry off the current from the metallic casing. A small quantity of mercury, or other conducting fluid, is supplied to the interior of the casing, and distributes itself around the whole of the casing's inner circumference whenever the disc is revolved. Or in place of this arrangement rubbers, lubricated with mercury, may be employed. From the axis the current can similarly be conveyed away by bosses on the axis surrounded by fixed metallic casings, and with mercury or other conducting liquid supplied to the intervening space—or it might be carried off from the axis by rubbers bearing upon it as in other dynamo machines. All parts of the machine with which the mercury used is liable to come into contact are coated by electro deposition, or otherwise with iron, or it might be other metal not affected by mercury. In order to be able at all times to ascertain the height of the mercury in the annular chamber surrounding the outer circumference of the disc, the inventor employs pairs of insulated wires—the several pairs opening into the chamber at different distances from the axis. The ends of the wires are left bare. When there is sufficient mercury in the chamber to make an electrical connection between the ends of the wires of any one or other of the pairs, an electric current may pass from one wire to the other of the pair, and the passing of the current may be indicated on a galvanometer or bell, or other recording instrument. Or single wires connected to galvanometers might be used, and the circuit completed through the body of the machine. Machines constructed as above described may be used not only for the production of a continuous current, but also for obtaining motive power from a continuous electric current. Or if a continuous current be passed radially through the disc, and the disc be revolved, a current may be carried off from the coils of the electro-magnets. In this case the magnet pole pieces or cores would not be required. Fig. 1 shows a longitudinal section, and fig. 2 an end view of a machine constructed

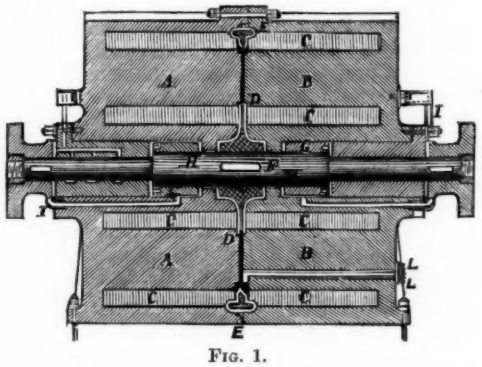


FIG. 1.

as above described. A, B, are cylindrical magnet cores or poles facing one another, and one North and the other South. Each of these is surrounded by a cylinder, A^1, B^1. The outer cylinder, A^1, is in one piece with the rear end of the magnet core, A; the other cylinder, B^1, is in one piece with the rear end of the magnet core, B. The inner ends of the cylinders, A^1, B^1, are bolted together by bolts, A^*. Around the exterior of each magnet core is a coil, C, of an insulated conductor. Each coil is preferably formed of a conducting strip set edgewise, that is, the broader sides of succeeding coils are towards one another, but it might be of wire or strips of other form. D, is the disc preferably of copper, electro plated with iron. E, is the metallic casing surrounding the circumference of the disc. This casing is insulated on its exterior. F, is the axis which carries the disc; it is mounted in bearings, F^1, as shown in fig. 1. F^2, are belt pulleys by which the axis may be driven. G, G, are bosses screwed on to the axis; they hold between them the boss of the disc, D. The bosses, G, also lie in chambers, H, partly filled with mercury, so that the axis is put into electrical connection with the blocks, A and B, which form the body of the machine. I, I, are passages by which mercury may be poured from small cisterns or funnels, I^1, I^1, into the chambers, H. K, is a pipe by which mercury may be supplied to the insulated casing, E. F^3 are passages by which lubricating oil may be supplied to the bearings from oil cups, F^4 (see fig. 2). The exciting current to be passed through the two coils, C, may be obtained by putting the inner end of each coil in electrical communication with the insulated casing, E, and the outer end of each coil in electrical communication with the blocks, A and B, respectively; or the exciting current might be conveyed to the coils through insulated conductors led out through the blocks, A and B, in the manner shown at $C^\times$, fig. 1. One set of terminals for leading off the current from the machine may be at any desired points on the exterior of the blocks, A and B; the other set of terminals are carried by insulated blocks, E^1, which, by insulated rods, E^2, are in electrical connection with the inner insulated casing, E. J, J, in fig. 2, are gauge glasses, by which the height of mercury in the inner casing, E, can be ascertained when the

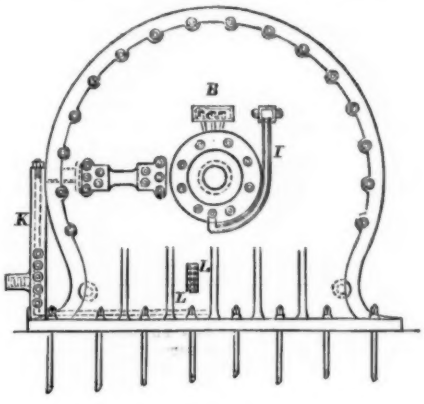


FIG. 2.

machine is standing. They are closed at their upper ends by screw caps—any excess of mercury can be drawn off from the bottom of the gauge, whilst, if more mercury is required, it can be supplied through the pipe, K.

5939. "Electro motor engines for railways." F. H. DANCHELL. Dated December 31. 6d. Relates to the apparatus described in the Number of the REVIEW for December 22nd, 1883.

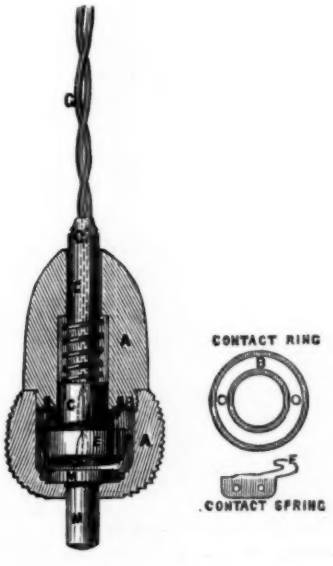
5964. "Telegraphic and telephonic apparatus." D. SINCLAIR and J. L. CORBETT. Dated December 31. 6d. The objects of the present invention are (1) to improve the construction and simplify the arrangement of apparatus for enabling branch exchanges to be worked automatically as described in the Specification of Letters Patent granted to Daniel Sinclair and dated 7th July, 1883, No. 3380; and (2) to enable a number of subscribers in a district to be connected to a central exchange by a single trunk wire, through which any subscriber may call or be called by the central office, and be placed in communication with any other subscriber on the telegraphic or telephonic system without passing through a branch exchange.

5992. "Apparatus for lighting gas by electricity, &c." C. L. CLARKE. Dated December 31. 6d. Relates to the apparatus described on page 146 of the number of the REVIEW for last week.

1884.

131. "Improvements in electro-dynamic machines." H. J. ALLISON. (Communicated from abroad by R. N. King, of America.) Dated January 1. 6d. Relates to the apparatus described in the number of the REVIEW for May 24th, 1884.

149. "Improvements in pulls and pushes for electrical bells." C. SMITH. Dated January 1. 4d. A contrivance of parts and a



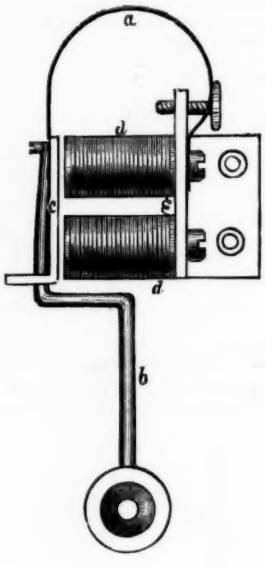
spring so arranged and insulated in a handle for a bell as to act as a bell pull or push or both combined, thereby dispensing

with the usual spring crank used to bring back the bell pull, in bedrooms, on entrance doors, and for invalids, &c., and will work in any position. The fig. is a section of pull and push combined, in which A is handle of bell pull made in any suitable material, preferably wood or ivory, to which is fixed B, metal contact ring, through which passes C, insulating tube of ebonite, on which is formed a swell or shoulder supporting D, spiral spring, and on bottom of ebonite tube a flange, E, carrying metal contact springs, F, to which is attached bell pull wires, G, held by screws and washers, H; the wires in this case pass from pull to ceiling or terminal box, I, inside of which is J, reel of ebonite or wood, carrying the wires, G, to terminal screws, K, and to which is connected line wires, L; M, is push piece of pull, and is suitable for bedrooms and invalids.

3322. "Improvements in grips for electric cars." A. M. CLARK. (Communicated from abroad by J. C. Henderson, of America.) Dated February 14. 6d. The clamp consists of a Y-shaped bar, whose forked end passes through a slot in the duct, and carries rollers which bear on the upper and under side of the rail in the tube, the friction or bite of the lower rollers being regulated by drawing up the clamp by means of a screw.

6128. "Improvements in electrical conductors or leads, to be used in buildings, and for other purposes." M. SUGAR. Dated April 8. 4d. The inventor makes conductors or leads of copper or other suitable metal, and flattens them in lengths to a certain shape and size, after which he covers them with a waterproof insulating substance.

6234. "Pendulum indicator for electric bells." E. P. TIMMINS. Dated April 10. 6d. Consists of a pendulum suspended to one end of a curved or bent spring, the other end of which spring is attached in any suitable manner to the casing of apparatus or other suitable support, and attached to the spring aforesaid is an armature. By forming the pendulum suspender of a curved or bent spring, as aforesaid, and attaching the armature thereto, instead of to the disc or wire of the pendulum itself, as in ordinary pendulum indicators, greater sensitiveness in regulation of vibration is obtained. Furthermore, the armature of pendulum, when

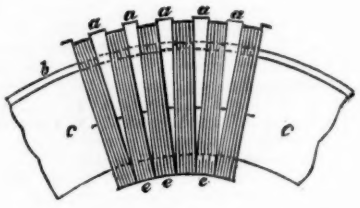


latter is suspended by a hinge, frequently sticks to the magnet, as the pendulum alone is not always sufficient to bring it away if any residual magnetism remain after current has ceased. The spring in this invention obviates this defect. The fig. is a front elevation of the improved pendulum indicator, provided with a two-bobbin electro-magnet. *a* is the curved or bent spring, to one end of which the pendulum, *b*, is suspended. *c* is the armature attached to spring, *a*. *d*, *d* are the electro-magnets.

8447. "Bracket for incandescent electric lamp." W. E. H. SCHABINA. Dated May 30. 6d. Relates to a construction of bracket projecting from a wall or partition to carry an incandescent lamp at its end, with means of making or breaking electrical contact by turning a button at the end of the bracket.

8532. "Improvement in presses for moulding glass insulators." L. B. GRAY and J. HAM. Dated June 3. 4d. The inventors construct the plunger of a press for moulding glass insulators in such manner that a glass insulator may be pressed into a suitable mould, so as to form a continuous screw-thread within the opening of the insulator, and then, by contracting the screw-thread of the plunger, permit its removal therefrom by a single upward movement, without disturbing the screw-thread thus formed.

9536. "An improvement in the ring armatures of certain dynamo-electric or electro-dynamic machines." R. E. DUNSTON. Dated June 28. 4d. In ring armatures of the Pacinotti or Gramme kind used in certain dynamo-electric or electro-dynamic machines, as the wire coils have approximately parallel sides, the spaces between them on each side of the ring are necessarily wedge-shaped, as illustrated in the fig., which shows a side view



of part of the ring, *c*, having on it parallel sided coils, *e*. The spaces are sometimes filled with wedge-shaped pieces, *a*, of wood or like material. The new invention consists in fixing between the coils pieces of iron, *a*, which may be either made in solid pieces or built up of strips, so as to project a little beyond the external faces of the coils, *e*, and therefore to pass very close to the field-magnets, which are thus made to exert more influence on the coils.

CORRESPONDENCE.

The late Mr. Volckmar.

The paragraph under the above heading in your issue of the 23rd inst., extracted from the New York *Electrical World*, and signed by the singularly inappropriate *non de plume* "Verax," is such an obvious jumble of fact and fiction, that it might well pass unnoticed, were it not that some of the mis-statements might at a future time be referred to as a matter of history in connection with electrical accumulators, and might possibly be considered by some who are ignorant of the facts as prejudicial to the interests of my company if they remain uncontradicted.

It is not within my province to touch upon the private affairs of the late Mr. Volckmar. What is presumedly of interest to your readers is the statement made in connection with the "accumulator patents," viz., that the "Sellon-Volckmar" accumulator is simply a reproduction by a friend of Mr. Volckmar's (Mr. Gustave Philippart) of improvements made by Faure, worked out under the auspices of Mr. Sellon.

It is right to place on record that Mr. Sellon, who took out his important and comprehensive patents in September, 1881, never heard of the name even of Mr. Volckmar or of Mr. Gustave Philippart until some months afterwards, viz., in December of that year, when Mr. Volckmar was presented with introductions of a high class to him and to other gentlemen interested in electrical matters in England.

The inventions were made quite independently of each other, and effected in different countries, Mr. Volckmar having worked entirely in France, and his specification was taken out a month later than Mr. Sellon's, viz., in October, 1881.

The association of the two names is incidental to the fact that the Electrical Power Storage Company secured both patents, together with Mr. Swan's and others, and subsequently the Faure patents, the combination covering the whole ground of electrical accumulators.

The assertion that the Sellon and Volckmar patents are in any way infringements of the Faure should not be allowed to pass unnoticed, although, as my company possess them all, it is not material. The fact is, however, that of the several claims not one is in common,, but it is a well authenticated fact that the Faure patent without the combination of the Sellon-Volckmar, is impracticable, and that its entire value is given to it by such combination.

Electrical Power Storage Company, Limited,
H. DELL, *Secretary.*

London, E.C., *August 26th*, 1884.